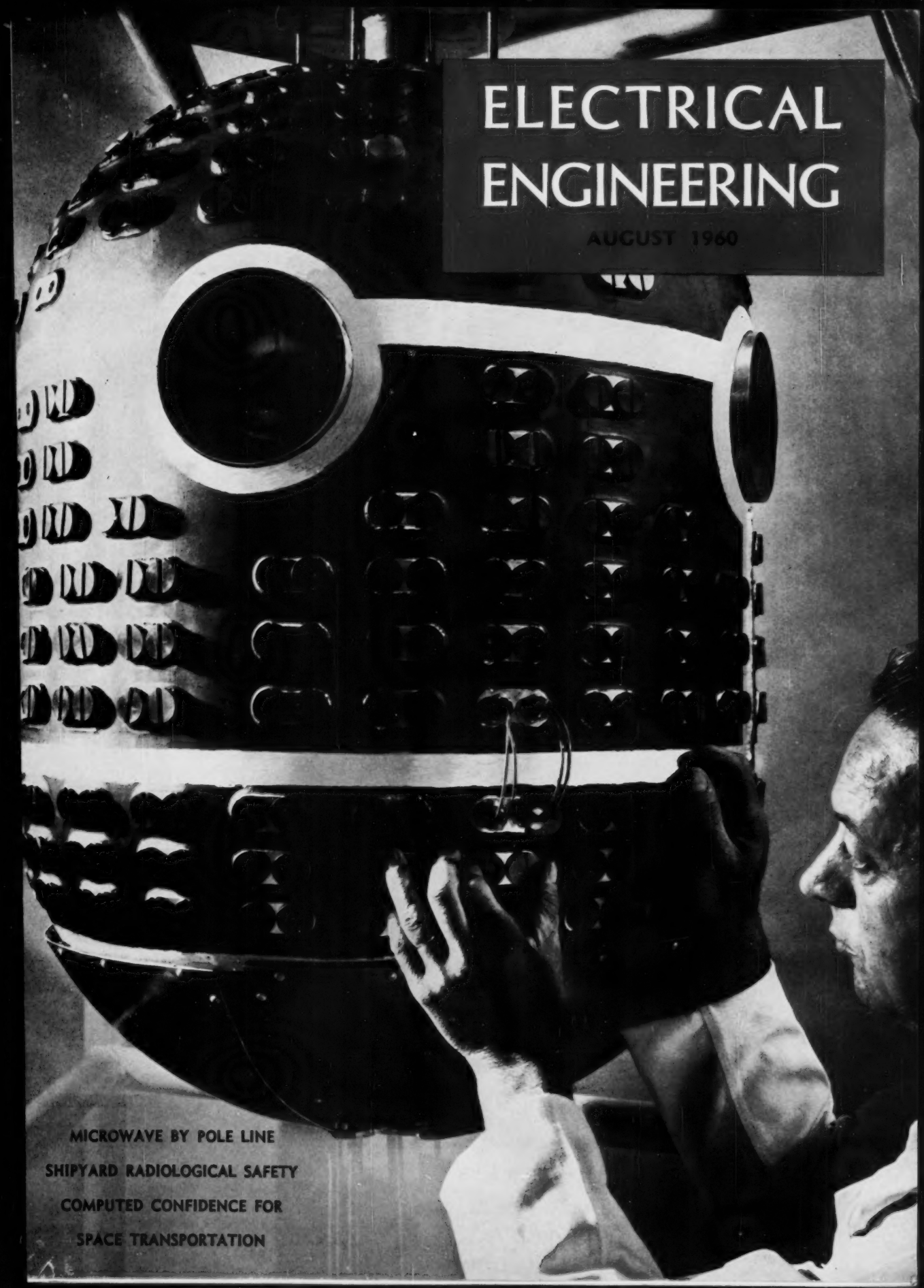
ELECTRICAL ENGINEERING

AUGUST 1960

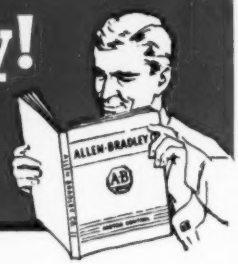


MICROWAVE BY POLE LINE

SHIPYARD RADIOLOGICAL SAFETY

COMPUTED CONFIDENCE FOR SPACE TRANSPORTATION

Some more special controls that are "standard" with Allen-Bradley!



Even Khrushchev couldn't claim a more complete line!

Phase Failure Phase Reversal Relays

The Bulletin 812 Style RF relay responds to *all* open phase conditions on a branch motor circuit and immediately removes the motor from the line. Also, the motor is disconnected when a phase reversal occurs anywhere in the system on the line side of the relay. "Fail safe" design.

Phase Failure, Style F covers f.l. currents from 1.5 to 300 amp in 4 sizes. Coils to 600 v, 60 cycles.

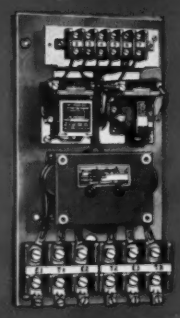
Phase Reversal, Style R made with coils for 110, 208/220, 440, 550 v for either 50 or 60 cycles.

Zero Speed Switch

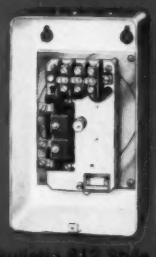
Used for "plugging" duty, these switches prevent coasting and bring squirrel cage motors to a sudden stop. Also used to prevent application of reverse power before motor comes to a full stop. Adjustable operating speed.

Low Pressure Switch

Especially designed for domestic water pump service and commercial air compressor service. These inexpensive compact switches offer pressure ranges from 15 to 200 psi.



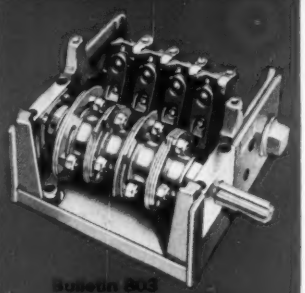
Bulletin 812 Style F



Bulletin 812 Style R

Bulletin 808

Bulletin 830



Bulletin 803

Bulletin 805

Bulletin 836 Style T

Bulletin 837 Style A

Rotating Cam Limit Switches

Heavy-duty pilot controls used on rotating machines to initiate functions at any point of rotation. Made with up to 12 individually adjustable, independent circuits.

Foot Switches

Built for toughest service. Has maintenance free, snap-action contacts. Extended base prevents tipping. Made with hood (left), with top guard and without guard.

Pressure Controls

Oiltight enclosure for machine tool hydraulic systems operating at pressures up to 5000 psi. Operating pressure and differential are adjustable. Indicator shows trip point. Silver contacts never need service attention.

Temperature Controls

Newly designed bellows provides lower differentials. Rugged construction permits continuous cycling from zero to maximum setting. Vibration or mounting angle will not affect accuracy of operation. Temperature ranges from —150°F to 490°F.

ALLEN-BRADLEY *Quality* Motor Control

Member of NEMA

Allen-Bradley Co., 1301 S. First St., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

ELECTRICAL ENGINEERING

AUGUST 1960
Vol. 79, No. 8

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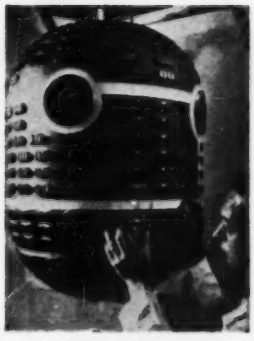

THE COVER: SNAP 1-A, "big brother" of the grapefruit-size SNAP-3 generator which was unveiled by President Eisenhower last year, is prepared for electrical tests at The Martin Company in Baltimore, Md. Heat from tightly sealed pellets of an atomic waste material, Cerium-144, will be converted directly and continuously into 125 watts of electric power by hundreds of thermocouples which dot the outer skin of the device. Story on p. 705.

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from the Panama Canal — 1912
to AEIC-EEI Cable Project — 1960

G&W DEVELOPMENT INCREASES POTHEAD RATINGS 7175 VOLTS A YEAR

Nearly a half-century ago, G&W furnished a 600 volt disconnect type pothead which was flexible enough to meet the complex demands in lock control rooms of the Panama Canal. The success of this device is a proven fact since these potheads are still supplied for service today.

Now, G&W's latest development, a 345 kv cable termination for the AEIC-EEI Project, is a significant contribution to the further progress of power transmission and distribution. Each pothead is more than 12 feet high and weighs approximately 2,000 pounds. They are designed to withstand nominal operating pressures of 200 psi and exceed the 1300 kv impulse voltage withstand specified by the project sponsors. Capacitors distribute the high-voltage uniformly along the length of porcelain from aerial lug to ground.

From the construction of the Panama Canal to the present, 48 years of continuous development by G&W have gone into one product. No more thorough job has been done by any single manufacturer. Nor is there a more complete line of potheads available than that offered by G&W. Ask your G&W representative for full details, or write us.

One of three G&W potheads installed at the AEIC-EEI Project, this unit is more than twelve feet high and weighs 2,000 pounds. If tests at 345 kv are successful, as expected, these potheads and other accessories and cable will be tested later at 450 and 500 kv phase-to-phase.

AT60-2

G&W ELECTRIC SPECIALTY COMPANY
3510 WEST 127TH STREET • BLUE ISLAND, ILLINOIS
CANADIAN MFR. • POWERLITE DEVICES, LTD.
TORONTO, MONTREAL & VANCOUVER

superior quality standards—inspired specialized design

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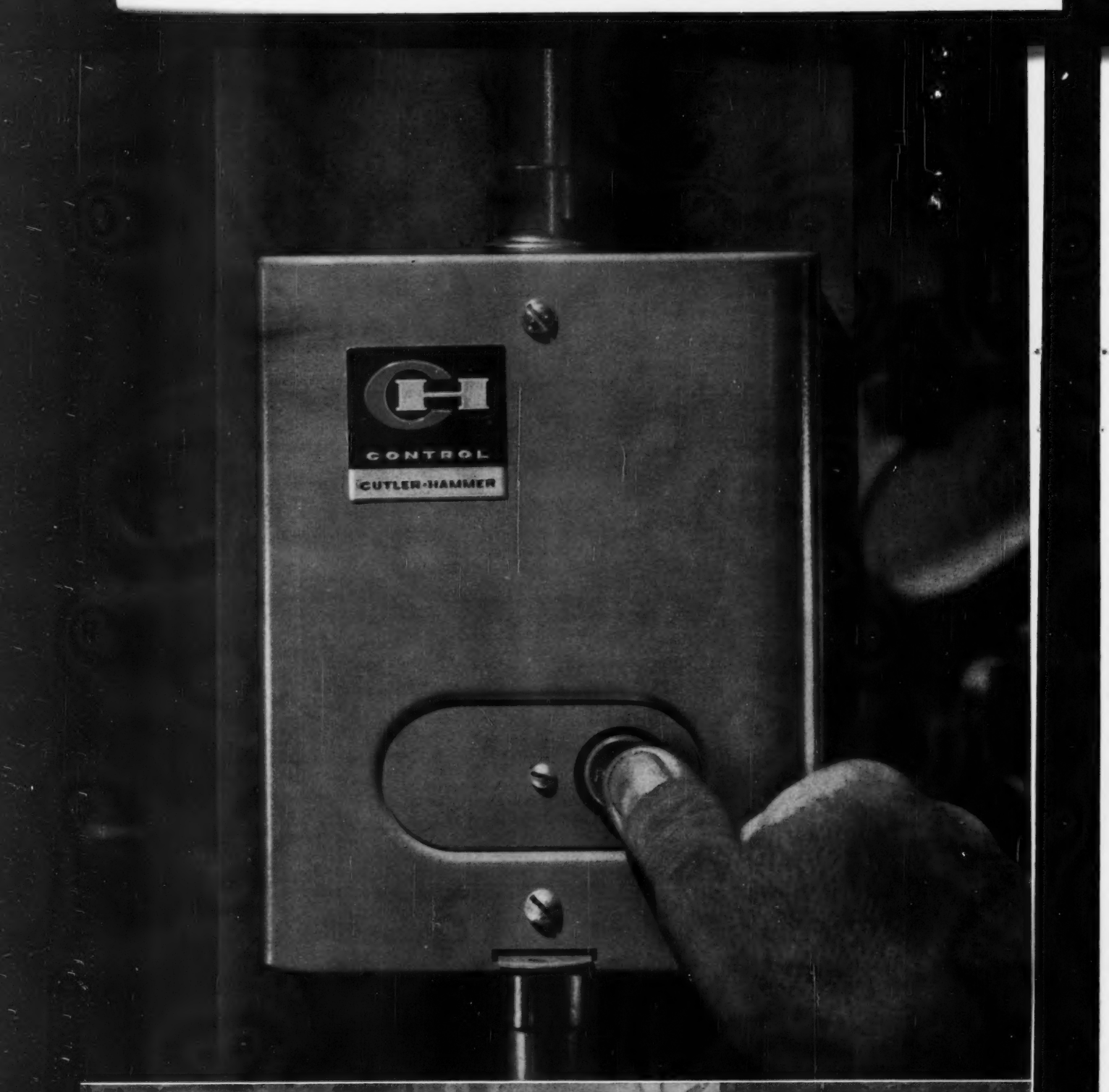
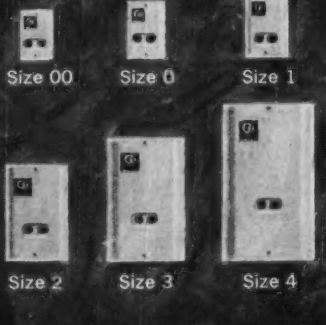


Smaller! About 20% smaller than Size 0 Starters. Just 5 3/4" wide, 7" high and 4 3/16" deep.

Convertible! Carried in stock with three cover options or easily converted in field from "reset" only to "start and stop-reset" or "three-position selector switch." Kits at optional cost.

Broad line!



A new addition to the famous three star line

New! Save space and money with Cutler-Hammer's Size 00 A-C Magnetic Starter

Takes up to 20% less space... costs 18% less than Size O Starters. Now you get two big new bonuses in control selection . . . less space and less money Both with the all new Size 00 Starter.

Before, you had to use a larger starter in applications where it really wasn't needed. But, now you can use the Size 00 in about 40% of the applications where the Size 0 is usually used.

The new Cutler-Hammer Size 00 Starter performs to the same high standards you get from all Cutler-Hammer Starters. And, you still get vertical, dust-free contacts which add so much to more reliable starter performance. Your choice too, of 2-coil or 3-coil overload protection in the same small enclosure.

The Bulletin 9586 Size 00 Starter can be used on any general application. Its maximum horsepower ratings: Three phase: 208/220 volts, 1½ hp. 440/550 volts, 2 hp. Single phase: 115 volts, ⅓ hp. 230 volts, 1 hp. It's available open or in NEMA 1 enclosure. Send for Pub. LO-40-Q228.

Why you get more from Cutler-Hammer. New things are happening at Cutler-Hammer—new, better products, new engineering ideas and talent, new plant capacity. We're on the move. And, we'd like to show you how we could help you in any electrical control problem. Contact the nearest Cutler-Hammer distributor.

WHAT'S NEW? ASK...

CUTLER-HAMMER

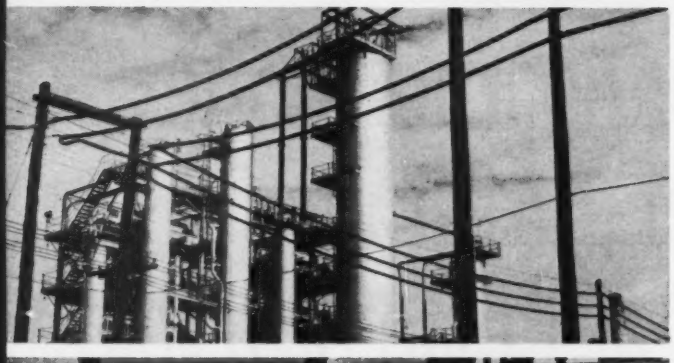
Cutler-Hammer Inc., Milwaukee, Wisconsin • Division: Airborne Instruments Laboratory • Subsidiary: Cutler Hammer International, C. A. Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A

How Okonite solves your High-Voltage Distribution Problem

Reliable primary distribution is a must for efficient, economical operation. As the use of higher voltages increases, the problems of keeping primary distribution reliable increase too. But, whatever your specific need, Okonite has designed a construction that will do the job . . . like those shown here.

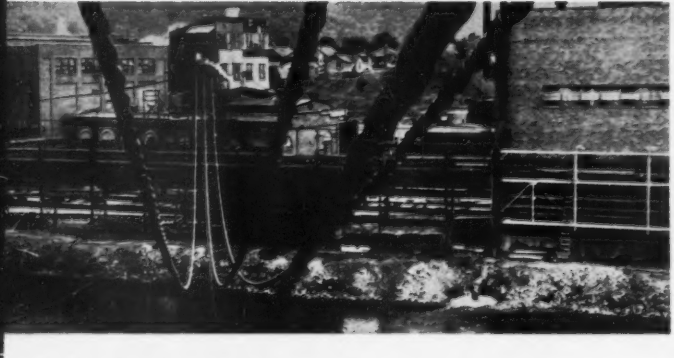
OKOLITE-INSULATED

This Okolite-insulated 25kv submarine power cable, installed by Bonneville Power Administration under Puget Sound, was 7½ miles long, weighed ¾ million lbs. It is typical of the many Okolite-insulated cables designed to solve specific high voltage power problems. Other constructions for underground, aerial, duct or interior installation are frequently protected by an Okoprene (neoprene) sheath, compounded to Okonite's own formula for high weather, temperature and abrasion resistance. Okolite oil-base insulation has demonstrated in more than 30 years of service its high dielectric strength, moisture-resistance and stability in all types of installation conditions. All Okolite-insulated cables must withstand self-imposed a-c and d-c voltage tests that are highest in the industry.



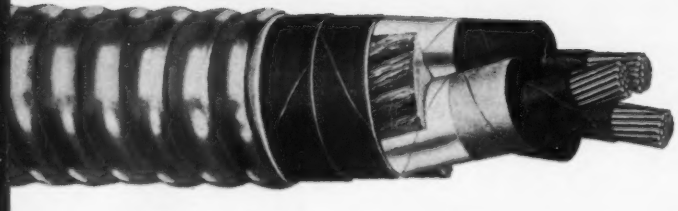
OKONEX-OKOPRENE

This Okonex-Okoprene 15kv primary distribution system was installed to save space, eliminate safety problems and provide improved voltage regulation at Magnolia Petroleum's 1500-acre refinery near Beaumont, Texas. Okonex (butyl-base) cables are highly resistant to heat, and are often specified to give additional protection in high ambient parts of the plant or to provide additional ampacity in circuits. The Okoprene sheath provides excellent protection against moisture and corrosion as in Magnolia Petroleum's refinery where there was a high moisture-saline content in the air plus chemical atmospheres at many of the processing units.



SELF-SUPPORTING CABLE

These four 7500-volt Okolite-Okoprene self-supporting aerial cables span 395 feet to distribute power to a section of a Southern paper mill. Easy to install in one simple operation, Okolite-Okoprene self-supporting aerial cable reduces clearance space requirements, is neat-appearing, often may be installed on existing buildings or supports, offers greater safety to personnel and eliminates insulator flashover due to contamination. Okonite's patented Dualay assembly can be tapped hot at any point in non-shielded types.



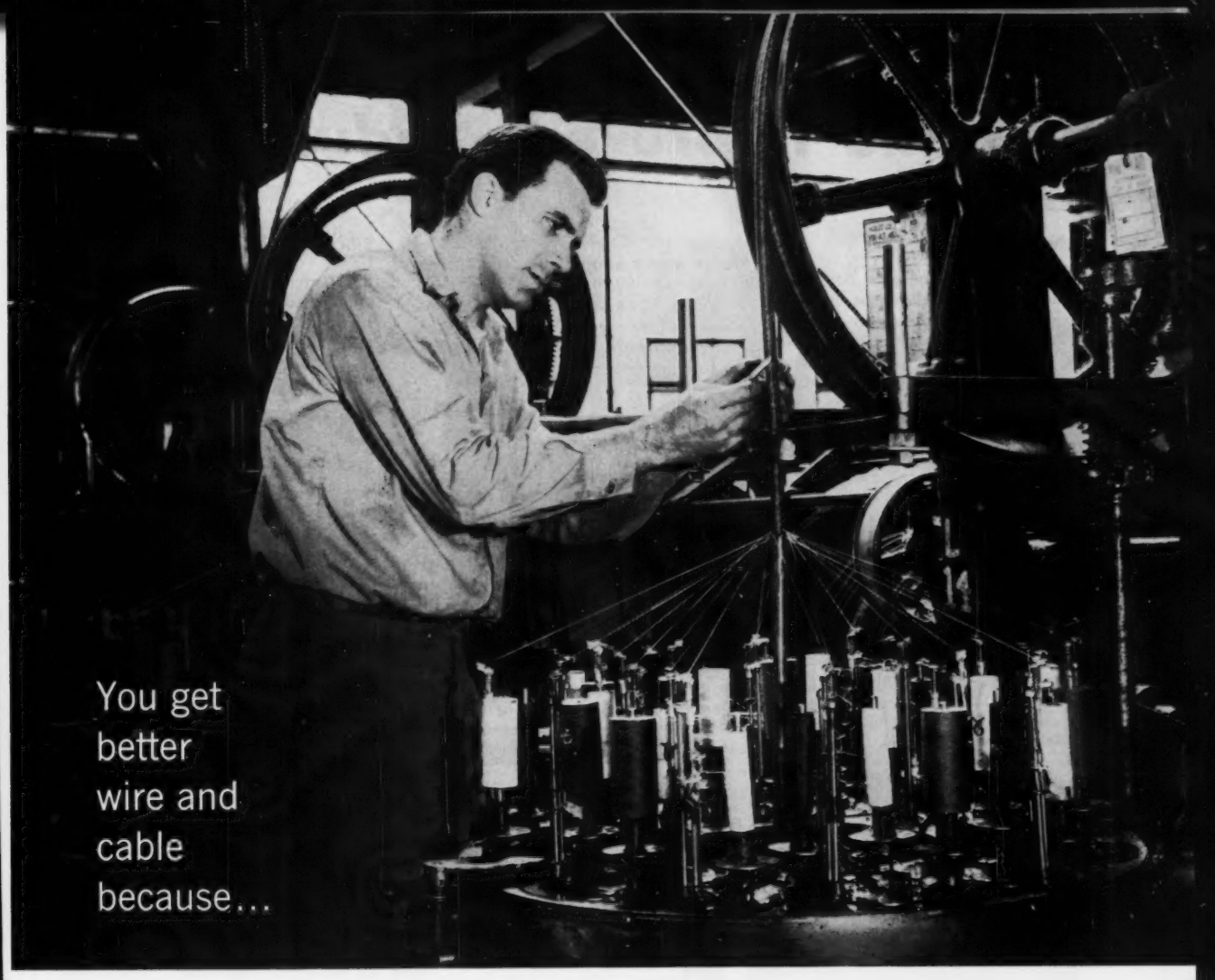
LOXARMOR

And on any high-voltage construction, a Loxarmor covering offers economy and flexibility in a cable system where the complete protection of a rigid conduit system is not required. Excellent mechanical protection is provided by a Loxarmor interlocking "S" tape available in galvanized steel, aluminum, bronze or copper. Loxarmor saves money in installation and initial purchase costs, makes it easy to add or re-route circuits and requires less space than conduit to handle the same number of circuits.

One of these high-voltage cable constructions will fill your requirements. Write for Bulletin EG-1117, "How to Choose Insulated Cable," to The Okonite Company, Subsidiary of Kennecott Copper Corporation, Passaic, New Jersey.

***where there's electrical power... there's* OKONITE CABLE**

7080



NEARLY EVERYONE AT CIRCLE'S AN "INSPECTOR"

Take Oscar Stangoni, braiding machine operator at Circle.

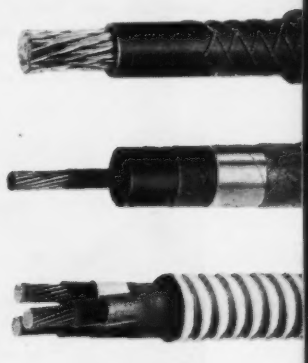
Mr. Stangoni doesn't need to use a micrometer. Ordinarily, his foreman sets up the machine, checks with a "mike" at the beginning of a run and several times during a run to make sure that the O.D. is OK.

But Oscar Stangoni uses one just the same—and he uses it often. Why? Maybe pride or a sense of responsibility—or maybe just because he feels better when he also knows the cable is absolutely right.

This is just one of many ways in which Oscar Stangoni and hundreds more like him at Circle make sure that the wire and cable they turn out is as good as it can possibly be.

And that's another reason, we believe, why Circle products have achieved their reputation for quality.

Next time you specify cable, we suggest you ask for Circle. There's no finer cable made. CIRCLE WIRE & CABLE CORP., Maspeth, N. Y.



CIRCLE WIRE & CABLE
a subsidiary of
CERRO DE PASCO CORPORATION

RUBBER COVERED WIRE & CABLE • VARNISHED CAMBRIC CABLE • PLASTIC INSULATED CABLE • NEOPRENE SHEATHED CABLE • CIRTUBE* EMT

New and Improved Products . . .

Lightweight Clamp . . .

The trend to compact design is evident in the development of this new, lightweight aluminum clamp used for full tension dead-end connections in electric conductors. Called the *301*, it was designed for installation on steel-reinforced aluminum conductors for sizes 6 to 2/0. Total weight is less than ¾ pound. *Aluminum Company of America, 1501 Alcoa Bldg., Pittsburgh 19, Pa.*

Solid-State Timer . . .

Although not yet commercially available, this electronic sequence timer is being shown to appliance manufacturers to demonstrate how computer transistor circuits can be used to replace the motors, gears, cams, contacts, etc. of mechanical timers. Major components of the device are a series of solid-state switching modules, an electronic clock, transistor power amplifiers to energize conventional washer components, and a series of programming selector switches. *P. R. Mallory & Co. Inc., Indianapolis 6, Ind.*

Rollout Switch . . .

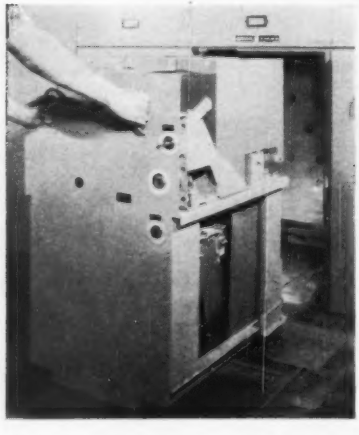
Major redesign considerations of this rollout switch and fuse equipment place emphasis on ease of operation, and safe, uncomplicated maintenance. New, simplified stored-energy mechanism can now be quick-charged with a single stroke of the operating handle. Quick-break tripping action results in less arc time, thereby giving greater contact life. The switch will close and latch against a full momentary current rating of 60,000 amperes on 2.4- through 7.2-kv systems, and on 50,000 amperes for systems up to 13.8 kv. *General Electric Co., Schenectady 5, N. Y.*

Protective Relay Tester . . .

Here is a newly designed relay test table with built-in instrumentation for checking practically all protective relays used in an electric power system. An output circuit tests over, under, or over/under voltage relays. A test position switch enables the operator to set normal voltage on the relay. He can then set a fault voltage while holding the normal setting, so that when the fault voltage is applied, the timing starts and is automatically removed when the relay contacts close. *Multi-Amp Electric Corp., 465 Lehigh Ave., P.O. Box 217, Union, N. J.*

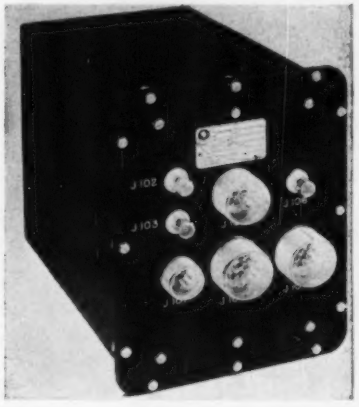
Flight Recorder . . .

Air speed, altitude, heading, vertical acceleration, and time are monitored once every second with this in-flight recorder, while 60 additional conditions governing the operation of an airplane can be monitored once every minute. This raw data, acquired during many hours of flight time, can then be fed into a large-scale computer for analytical processing. The result is a precise statistical means of determining what kind of maintenance is needed to sustain safe and efficient aircraft performance. *Minneapolis-Honeywell Regulator Co., 2600 Ridgeway Rd., Minneapolis 13, Minn.*



Silicon Rectifiers . . .

Rated at 10,000-volts peak reverse voltage and 1,250-ma d-c output, these high-voltage silicon rectifiers have tube bases for replacing existing types *8008* and *872A* mercury vapor rectifiers. Elimination of filament transformers and time delay relays will cut space and weight requirements in half. Other advantages associated with these silicon rectifiers are longer life, higher temperature operation, more rugged packaging, and elimination of warm-up time. *International Rectifier Co., 1521 E. Grand Ave., El Segundo, Calif.*



New Oscilloscope . . .

Three new products have been simultaneously announced by this company. Type *503* oscilloscope is a differential-input *X-Y* instrument with sensitivity of 1 millivolt/cm and a frequency range of d-c to 450 kc. Type 504 has a basic sensitivity of 5 millivolt/cm and vertical amplifier characteristics that include calibrated steps to 20 volts/cm, adjustable between 12 steps and to over 50 volts/cm uncalibrated. Type *516* is a dual-trace, semi-ruggedized instrument in the d-c to 15-kc range that is ideally suited for bench or portable applications. Basic sensitivity is 50 millivolts/cm per channel with four possible operating modes and a sweep range adjustable from 0.04 μsec to over 6 sec/division. *Tektronix, Inc., P. O. Box 831, Portland 7, Oreg.*

(Continued on page 9A)

New & Improved Products

(Continued from page 8A)

Calculator . . .

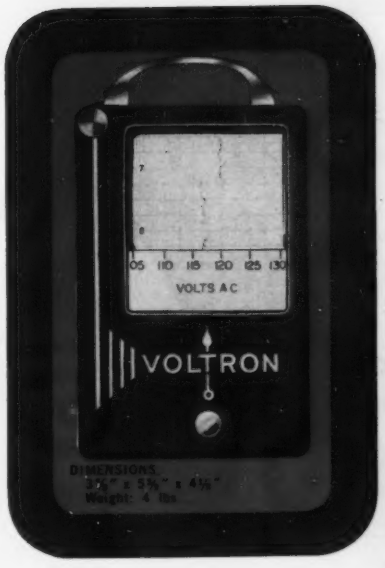
The latest model *609* is a low-cost solid-state punched card calculator that combines the functions of input, calculation, storage, and output into a single unit only 60 inches long, 20 inches wide, and 50 inches high. Its vacuum tube predecessor required several units to perform the same functions. The basic machine is equipped with 80 program steps, each of which is capable of performing three separate operations. Additional program steps may be incorporated in increments of from 16 to a maximum of 144. All are nonsequential, permitting the machine to make logical decisions as to what steps should be used to solve a problem without regard to their sequence. *International Business Machines Corp., 112 E. Post Rd., White Plains, N. Y.*

Microwave Frequency Meter . . .

Engineers who have struggled with the ambiguity and interpolation involved in reading conventional instru-

ments will appreciate this digital frequency meter that can be read at a glance. The high Q cavity is precision-bored and coupled to the narrow wall of a section of the waveguide. The mechanism is housed along with this cavity in a rugged casting which also provides support for the entire frequency meter. *Narda Microwave Corp., 118-160 Herricks Rd., Mineola, N. Y.*

(Continued on page 10A)



NEW MINIATURE RECORDER HAS ACCURACY OF ½%

VOLTREC

EXPANDED SCALE MINIATURE RECORDER

For
DC Voltage
AC Voltage
Frequency
Temperature

Small, compact, lightweight, the new Voltrec recorder monitors voltage or frequency with an accuracy of ±0.5%! It consists of two sections, a miniature inkless chart recorder that is a d'Arsonval meter with a free moving pointer against sensitized paper, recording once every two seconds, and an expansion network that expands the scale and achieves an accuracy of ½%. Transducers for expanded scale recording of AC volts, DC volts, frequency and temperature are available. Chart length 63', speed 1"/hr. — with variations up to 30"/hr. Portable or panel mounting. Write for details in Bulletin 602 or contact your local rep.

VOLTRON PRODUCTS, INC.,

1020 So. Arroyo Parkway
Pasadena, California

Virtually no maintenance (supplies can't be damaged even by direct short circuit of output); long life; extremely fast response; transient-free, ripple-free output; and wide input frequency tolerance—these are just a few of the major features you get in Sorensen Q and QR Series transistorized supplies.

They're ideal for critical applications like powering computer circuits, strain-gauge bridges, or low-level instrument circuits.

Q Series Supplies: Offered in 15 models with nominal output voltages of 6, 12, 28 vdc (adjustable 2:1, approximately) and up to 220 watts power capacity. Models available for either ±0.25% or ±0.05% voltage regulation (combined line and load). Available in either cabinet or 19" rack-mounting styles (15 and 25 W models can also be provided for dual rack mounting on a single panel).

QR Series Supplies: Feature wide-range adjustable output voltage—zero to rated voltage, continuously, with COARSE and FINE front-panel controls. Two standard models: 0-36 vdc, 4 amps max., or 0-75 vdc, 2 amps max. Output is regulated to within ±(0.02% + 1 mv). Output voltmeter and ammeter. Units are available for cabinet or rack-panel (19" x 5¼") mounting.

Get complete specs on these outstanding power supplies. Ask your Sorensen representative or write: Sorensen & Company, Richards Ave., South Norwalk, Connecticut. 0.3

Sorensen CONTROLLED POWER PRODUCTS
A SUBSIDIARY OF RAYTHEON COMPANY

New Sorensen catalog! Just off the press! 32-page catalog of more than 400 supplies plus valuable application data. Write for your copy today.

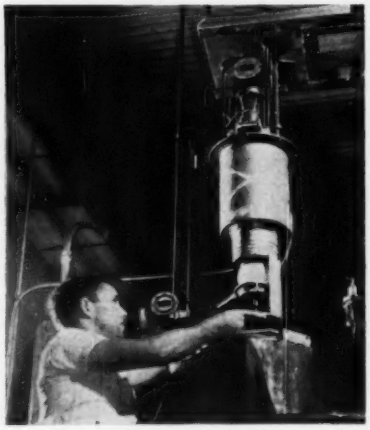
...the widest line lets you make the wisest choice
SEE US AT BOOTHS 509-510 AT THE WESCON SHOW

New & Improved Products

(Continued from page 9A)

3-Megawatt Klystron . . .

The first C-band multimegawatt klystron ever developed will be used to radar-track small, fast-moving tar-



gets. Its extremely high power is derived from a focusing system that squeezes more than 100 amperes of current into an intense, pencil-thin ray of electrons aimed down the center of the tube. While frequency range and bandwidth specifics are classified, the tube has a gain of 35-db, a minimum efficiency of 27%, and an ouput energy of 9 joules per pulse. *Sperry Gyroscope Co., Great Neck, N. Y.*

Precipitation Gauge . . .

Used to measure snow, rainfall, and water levels throughout an entire water shed, these new telemetering precipitation gauges will transmit accurate data to a central station via telegraph, telephone, or vhf radio links. A unique motor-driven tape probe and water surface sensor comprise the measuring device. The probe is raised at command from the bottom of a heated cylindrical measuring vessel, with one electric impulse being transmitted for every 0.1 inch of water traversed. These pulses are then telemetered to the central station, where a Veeder Root counter provides a cumulative reading. When the surface is reached, the pulses stop and the probe automatically returns to a reset position. *Advinco, 700 S. Fourth St., Richmond, Calif.*

(Continued on page 16A)

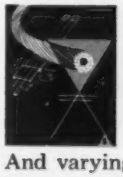
for the latest data on ACSR

126 fact-filled pages...from Alcoa

It took more than 60 years to prepare these three publications.

Recently completed tests have made it possible to review and revise data accumulated since 1897, the year Alcoa launched a continuous research program on overhead aluminum conductors— *both all-aluminum and ACSR*. The most up-to-date information has been put into book form to help you in your job:

Design or operation of transmission lines is your problem. Maybe you're called on to predict the resistance and reactance of a proposed transmission line. Are available data good enough? This 90-page book supplies you with new information on resistance and reactance—information that can help you accurately evaluate the effects of the steel core on electrical characteristics. TITLE: *Resistance and reactance of aluminum conductors.*

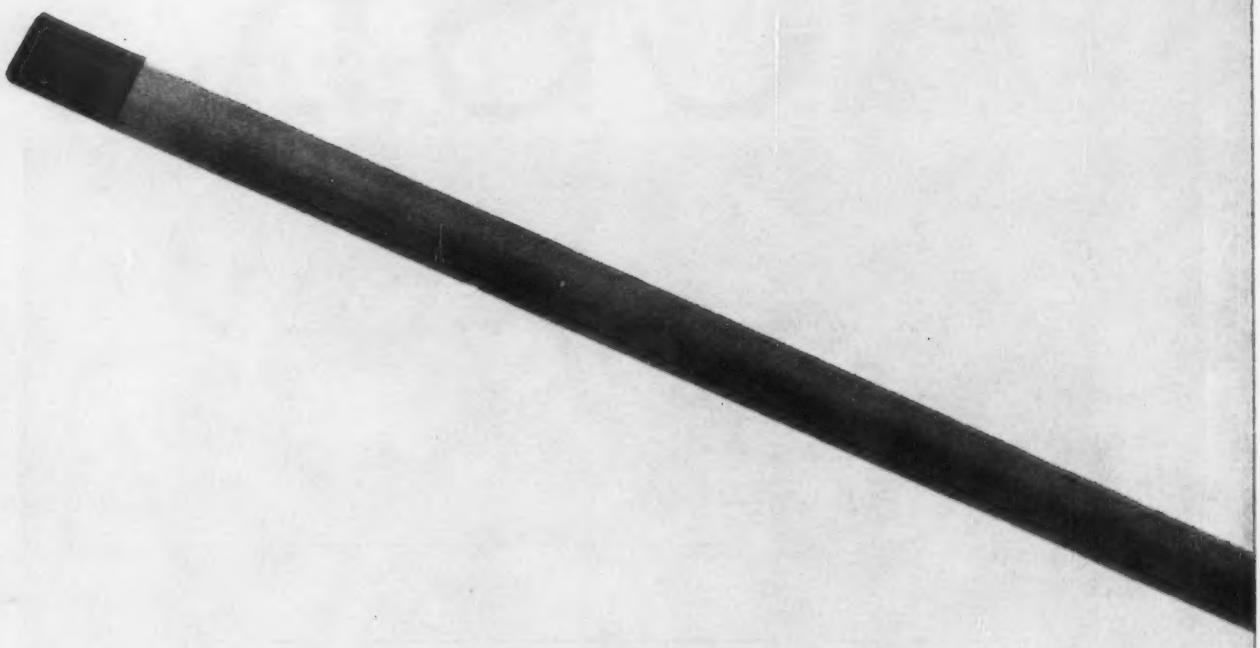


How much heat loss can you expect from convection? Tough problem. One that's complicated by the chimney effect of a heated conductor. And varying wind conditions. This 20-page publication provides up-to-date information on heat dissipation caused by convection and radiation. TITLE: *Current-temperature characteristics of aluminum conductors.*

Electrical requirements on your system go up. You need to operate conductors at higher temperatures than in the past. You ask yourself: what about creep effect? Here's a 16-page booklet that provides easy-to-use answers to many questions on how aluminum conductors behave when subjected to various conditions of heating by high overload currents. TITLE: *Overload and fault current limitations of bare aluminum conductors.*

Ask any one of our representatives for your copy of these new publications. Written requests on company stationery should be mailed to Rome Cable Division of Alcoa, Dept. 3-80, Rome, New York.

ROME CABLE
DIVISION OF **ALCOA**



the handle to a $5200

Just one stroke of the handle stores the closing energy in the new and unique Federal Pacific 5 KV and 15 KV circuit breakers. By eliminating outside power sources, the new breakers cut installation costs up to $5200 on battery, cable and control requirements alone. And "stored energy" is *safe* energy with Federal Pacific breakers . . . even for inexperienced operators! Our exclusive foolproof interlock prevents actuation unless instrument door is *closed and locked.* Also available . . . electric motor charged "stored energy" breakers . . . for new economy and reliability in unattended installations.

saving!

Motor charged breakers can be manually operated in case of control power failure. This new line of breakers is just one more example of the outstanding products and ideas from Federal Pacific . . . famous for over fifty years of leadership in "stored energy" devices. For all the facts on Federal Pacific's complete line of "stored energy" circuit breakers, write for Bulletin 6045. Federal Pacific Electric Company, Department FP-2, Newark 1, New Jersey.

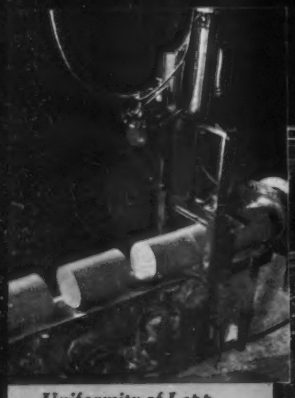
FEDERAL PACIFIC ELECTRIC COMPANY

FPE

growth through creative energy

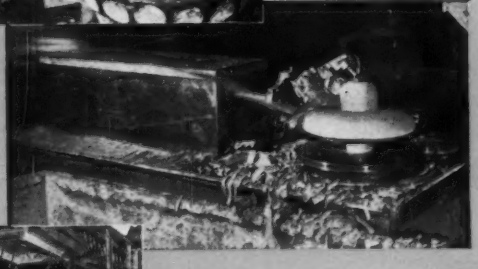
Modulus of rupture measurement, a routine laboratory check on strength of porcelain bodies, body-and-glaze combinations and sanded cementing surfaces.

At Lapp, suspension



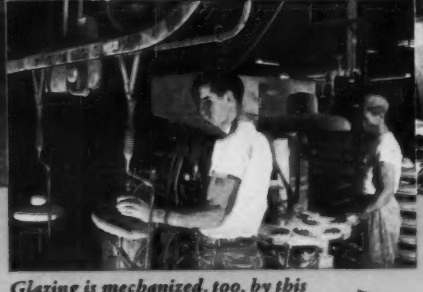
Uniformity of Lapp suspension discs begins with the billets of clay, automatically extruded and sliced to exact size.

Automation all the way! Plunging of lower surfaces of suspension discs is by this automatic machine.

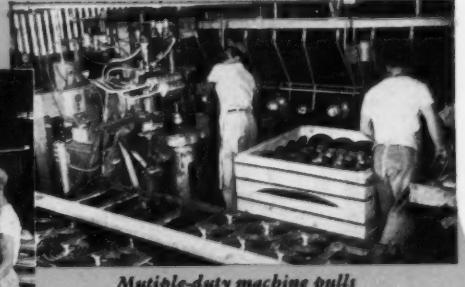


Plunged blanks, their moisture content controlled by an exact temperature-humidity-time cycle, are automatically trimmed to precise size and shape.

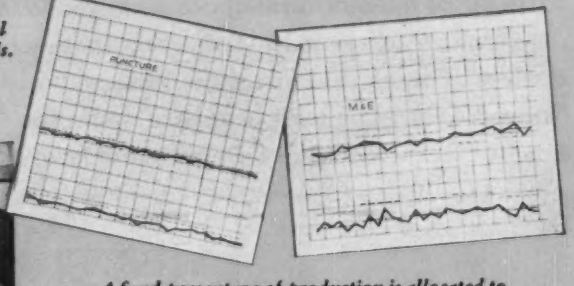
Uniform thickness of resilient paint on pins within insulator head is assured by this automatic pin-dipping machine.



Glazing is mechanized, too, by this machine which glazes insulator shells and applies uniform internal and external sand cementing bands.

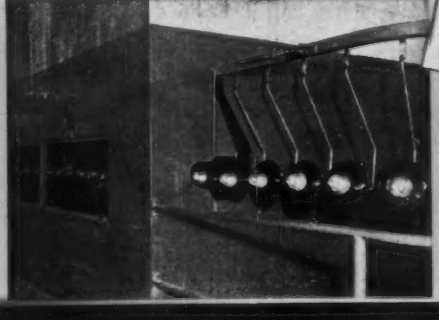


Mutiple-duty machine pulls each insulator at Proof Test Load and trims off surplus cement, paper used under cap.



A fixed percentage of production is allocated to quality control testing. Charts like these, of M&E and puncture values, show the continuing improvements in characteristics and uniformity resulting from Lapp production mechanization.

Every Lapp suspension unit is tested mechanically and electrically. This conveyer carries finished insulators through 60-cycle flashover test for a minimum period of three minutes.



insulator design and production are matters of continuous improvement

we make 'em good...
...and keep making 'em better

Take a look at your last shipment of Lapp suspension insulators. Compare them with some of Lapp's 40-year-old veterans you'll find serving on lines all over the country. You probably won't notice much difference. Yet they're nearly as different as is today's Thunderbird from 1920's Model T.

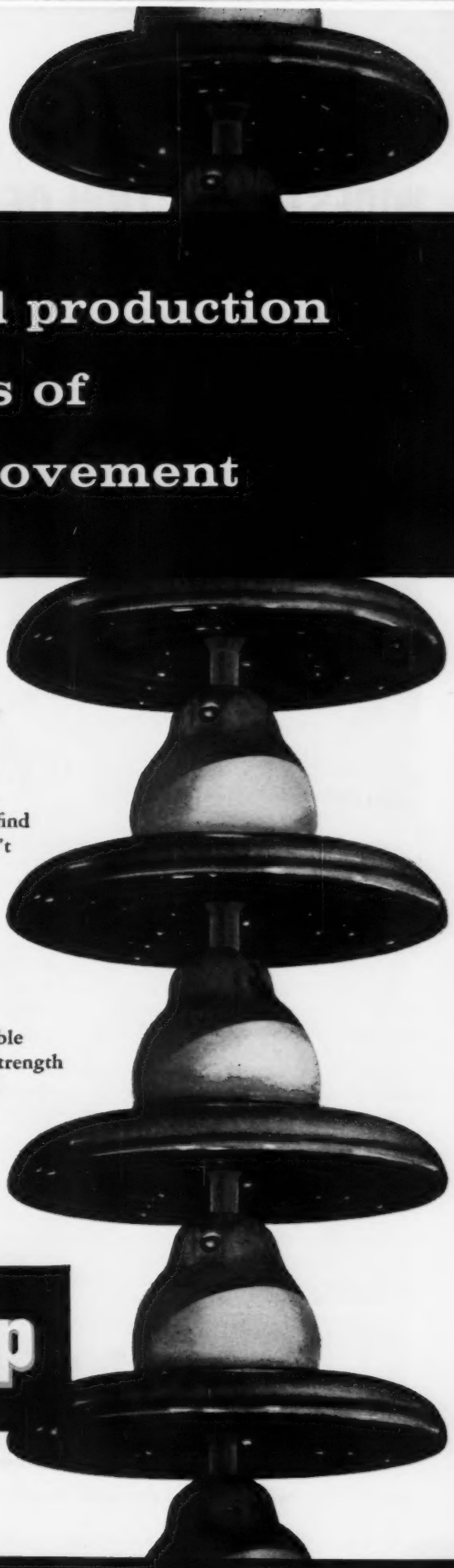
That's because product improvement is a continuous program with Lapp. We re-design, we test, we prove—and year-by-year we build valid improvements into our insulators and our production processes.

The results? Significant strengthening of every measurable characteristic. Elimination of even the maverick under-strength (and over-strength) individual units. Mechanization of every phase of production, for predictable uniform response to all test standards.

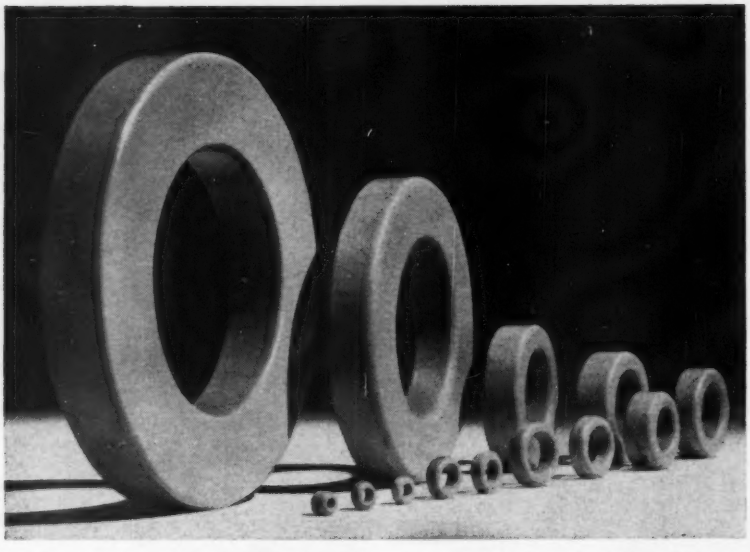
That's the way it is at Lapp. We make 'em good... but we keep making 'em better. And this extra we put into our suspension insulators merits your confidence when you install them, and means extra service after they're up.

Lapp Insulator Co., Inc.,
Le Roy, N. Y.

Lapp



ARNOLD:
WIDEST SELECTION OF MO-PERMALLOY POWDER CORES FOR YOUR REQUIREMENTS



For greater design flexibility, Arnold leads the way in offering you a full range of Molybdenum Permalloy powder cores . . . 25 different sizes, from the smallest to the largest on the market, from 0.260″ to 5.218″ OD.

In addition to pioneering the development of the cheerio-size cores, Arnold is the exclusive producer of the largest 125 Mu core commercially available. A huge 2000-ton press is required for its manufacture, and insures its uniform physical and magnetic properties. This big core is also available in three other standard permeabilities: 60, 26 and 14 Mu.

A new high-permeability core of 147 Mu is available in most sizes. These cores are specifically designed for low-frequency applications where the use of 125 Mu cores does not result in sufficient Q or inductance per turn. They are primarily intended for applications at frequencies below 2000 cps.

Most sizes of Arnold M-PP cores can be furnished with a controlled temperature coefficient of inductance in the range of 30 to 130° F. Many can be supplied temperature stabilized over the MIL-T-27 wide-range specification of −55 to +85°C . . . another special Arnold feature.

Graded cores are available upon special request. All popular sizes of Arnold M-PP cores are produced to a standard inductance tolerance of + or −8%, and many of these sizes are available for immediate delivery from strategically located warehouses.

Let us supply *your* requirements for Mo-Permalloy powder cores (*Bulletin PC-104C*). Other Arnold products include the most extensive line of tape-wound cores, iron powder cores, permanent magnets and special magnetic materials in the industry.

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SPECIALISTS in MAGNETIC MATERIALS

THE ARNOLD ENGINEERING COMPANY, Main Office: MARENGO, ILL.
BRANCH OFFICES and REPRESENTATIVES in PRINCIPAL CITIES

1187R1A

New & Improved Products

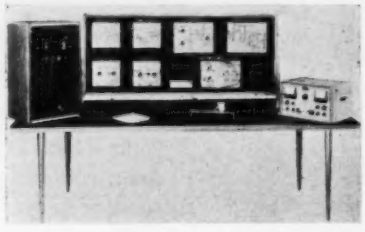
(*Continued from page 10A*)

Microwave Monitor . . .

Twenty-four microwave stations having a maximum of 20 functions at each station can be monitored simultaneously with this new alarm-fault finding system. Utilizing the microwave r-f baseband, the system consists of a master alarm station and a series of reporting stations. Should a fault occur, an alert is sent to the master station. The operator can then interrogate the station to determine which function caused the alarm. *Motorola Inc., 4501 West Augusta Blvd., Chicago 51, Ill.*

Feedback Control Demonstrator . . .

A demonstration board, an electronics rack, a mechanical breadboard, and a controls analyzer are the individual assemblies making up this packaged laboratory instrument for college and industrial teaching. The equipment provides in one integrated system all necessary components, test apparatus, and manuals required to perform linear and nonlinear feedback control experiments. *Superior Manufacturing and Instrument Corp., 154-01 Barclay Ave., Flushing 55, N. Y.*



Paper Tape Converter . . .

Called the *7765*, this latest device will convert punched paper tape data into magnetic tape information at the rate of 150 characters per second. Companies presently transmitting data with paper tape equipment will be able to achieve computer input several times faster than with direct paper tape input devices now available. The product is expected to bring many paper tape users into a position of being able to use tele-processing techniques. *International Business Machines Corp., 112 East Post Rd., White Plains, N. Y.*

(*Continued on page 18A*)

See our new products at WESCON—Booths 2250, 2251

NUMBER 6—APPLICATION SERIES

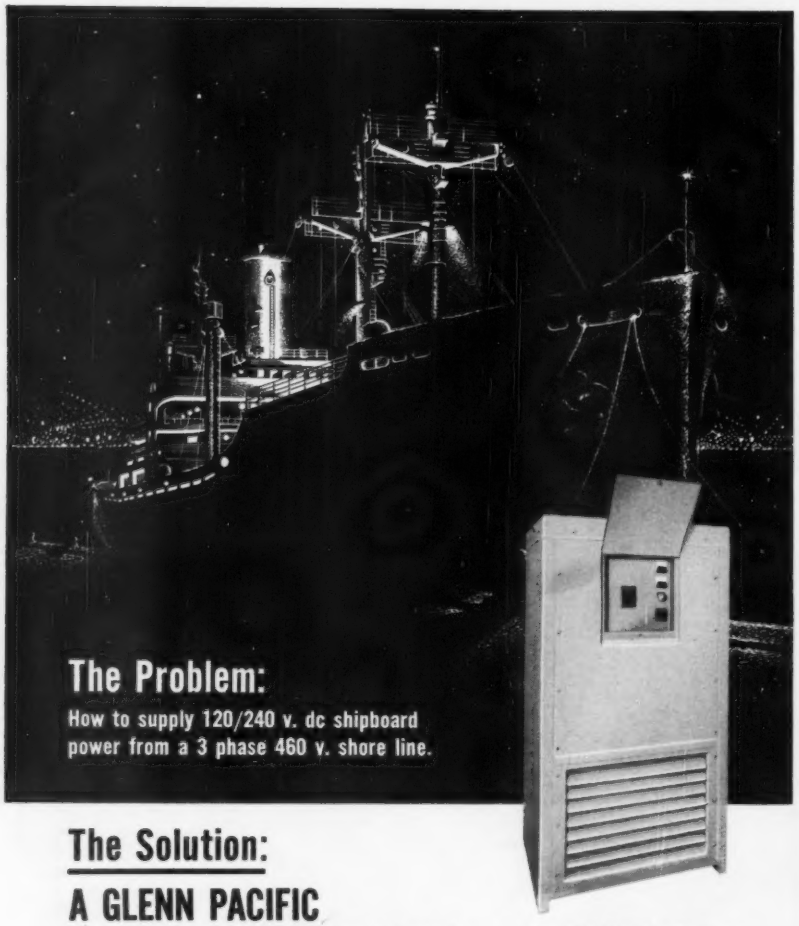
Bourns Trimpot® Instead of a Fixed Resistor?

Yes, these units meet the same Mil-Specs that fixed resistors meet and give you the added advantage of adjustability! Because of their design and construction, Trimpot potentiometers are virtually unaffected by the most severe shock and environmental conditions—a fact proven repeatedly in major missile and space programs.

Trimpot units offer several kinds of savings. They minimize the need to maintain stocks of close-tolerance resistors—you can adjust to compensate for the variances of fixed components. Production labor costs are cut, too, for Trimpot units eliminate trial-and-error matching of fixed units to the system. Savings also carry over to maintenance because the technician can adjust equipment quickly in the field—no time and dollars spent to replace components.

Before you specify fixed units, investigate all the advantages offered by Trimpot potentiometers. Over 20 basic models (wirewound and carbon)—in four terminal types and three mounting styles—are available on short notice from stocking distributors or factory. Get the facts...write for the new Trimpot brochure and list of distributors.

Exclusive manufacturers of Trimpot®, Trimit® and E-Z-Trim®. Pioneers in transducers for position, pressure and acceleration.



The Solution:

A GLENN PACIFIC INDUSTRIAL POWER SUPPLY

One of 10 Glenn Pacific Power Supplies supplied to the U. S. Navy for conversion of 3-phase 460 v. shore power to 120/240 v. dc for shipboard use; rated at 180 kva, continuous duty.

If available power as it comes from the line won't meet your needs, there's a good chance we can help solve your problem—and save you hours and dollars in the process.

As a pioneer in the development of heavy duty power supplies for automatic welding and similar industrial processes, we have three big advantages to offer. First, a lot of hard-earned experience that can save you costly mistakes. Second, a wide range of pre-engineered, custom components (fixed and variable-voltage transformers, heavy duty rectifiers, power capacitors, inductors, etc.) from which we can build a specialized power supply. Third, excellent facilities for designing and producing special components as required.

THE FIELD WE COVER... In general, power supplies rated from 15 kva up; input single, two or 3-phase ac; output either fixed or variable voltage, ac or dc. Constant potential, constant current, normal or high inductance (fixed or variable) designs available.

For typical examples of what we've done, and a better idea of what we can do for you, write now for our latest Industrial Power Supply bulletin. Please address Dept. 135.

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New & Improved Products

(Continued from page 16A)

Improved Potheads . . .

These type *AT* potheads, rated 69 to 35 kv for pipe-type cable, have been improved to meet increasing demands for high-voltage cable terminations. Variations in grade resulting in up to 200 psig hydrostatic pressure in the cable can easily be accommodated. Fully retained gaskets provide an improved pressure seal and simplify installation. A straight-through-type ferrule facilitates assembly and provides a stable connection to the overhead line while the cable conductor is held rigidly in the ferrule by indenting. *G & W Electric Specialty Co., 3500 W. 127th St., Blue Island, Ill.*

Noise Source . . .

A new uniform-spectrum noise source produces wide-band noise from semiconductors. Offered primarily as a component in laboratory noise generators, the unit may also be used as a

built-in noise source for sensitivity checks in radar and sonar systems, and in production test equipment for measurement of transfer functions of networks, amplifiers, and transducers. Because no a-c power supply is required, there is no risk of picking up unwanted 60-cycle hum. Other advantages of transistorized operation include immediate warm-up, and an unusually low power requirement of only 12 milliamperes at -12 ± 2 volts d-c. *Raytheon Co., 55 Chapel St., Newton, Mass.*

(Continued on page 28A)

ALLIS-CHALMERS

"Originators of 5/8% Step Regulators"

Caliband is an Allis-Chalmers trademark.

Lower! Lighter! Perfect for joint-pole use

new JFR regulators cut installation costs

CALIBAND control slashes setting time without changing customer voltage or interrupting service! A twist of the knob and you set or test voltage level and band width No need to return compensator settings to zero.

Allis-Chalmers all-new JFR is the top qualifier for joint-pole use . . . pad or platform mounting. Tank size and weight reduced up to 33%, due to JFR's improved materials and design techniques. Naturally, you save on transportation, handling and installation.

More new JFR advantages! Now offered as *standard*, position indicator drag hands reset by pushbutton on the control panel. A new, quick-sight gauge instantly reveals oil level. Exclusive unidirectional breather removes all moisture and contaminating gases. And a new cover, with hidden bushing mounting studs, cuts maintenance. *For all the facts ask your nearby A-C office for new JFR Bulletin 21B7977E or write* **Allis-Chalmers,** *Power Equipment Division, Milwaukee 1, Wisconsin.* A-1261

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50 AMP "ROCK-TOP" TRINISTOR[T] CONTROLLED RECTIFIER

PROVIDES MULTI-FUNCTIONAL CONTROL OF CURRENTS AND VOLTAGES WITH FAST SWITCHING TIME AND RESPONSE RATE

New Westinghouse Trinistor "Rock-Top" construction provides high reliability, low maintenance, and positive protection against arcing at high voltages. Design engineers will find the improved electrical characteristics, listed below, can be used to advantage in a wide range of new control and switching applications.

- Lower Thermal Impedance
- Switching time 600 millimicroseconds
- Efficiencies in excess of 95%
- Simplifies circuitry
- Lower forward drop than thyratrons
- Minimum noise levels
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INDUSTRIAL, MILITARY, AND COMMERCIAL APPLICATIONS INCLUDE: CONVERTERS / VARIABLE FREQUENCY CONTROLS / MOTOR CONTROL / VOLTAGE REGULATION / REPLACEMENT OF MAGNETIC AMPLIFIERS / HIGH POWER MODULATION / INVERTERS / REPLACEMENT OF THYRATRONS

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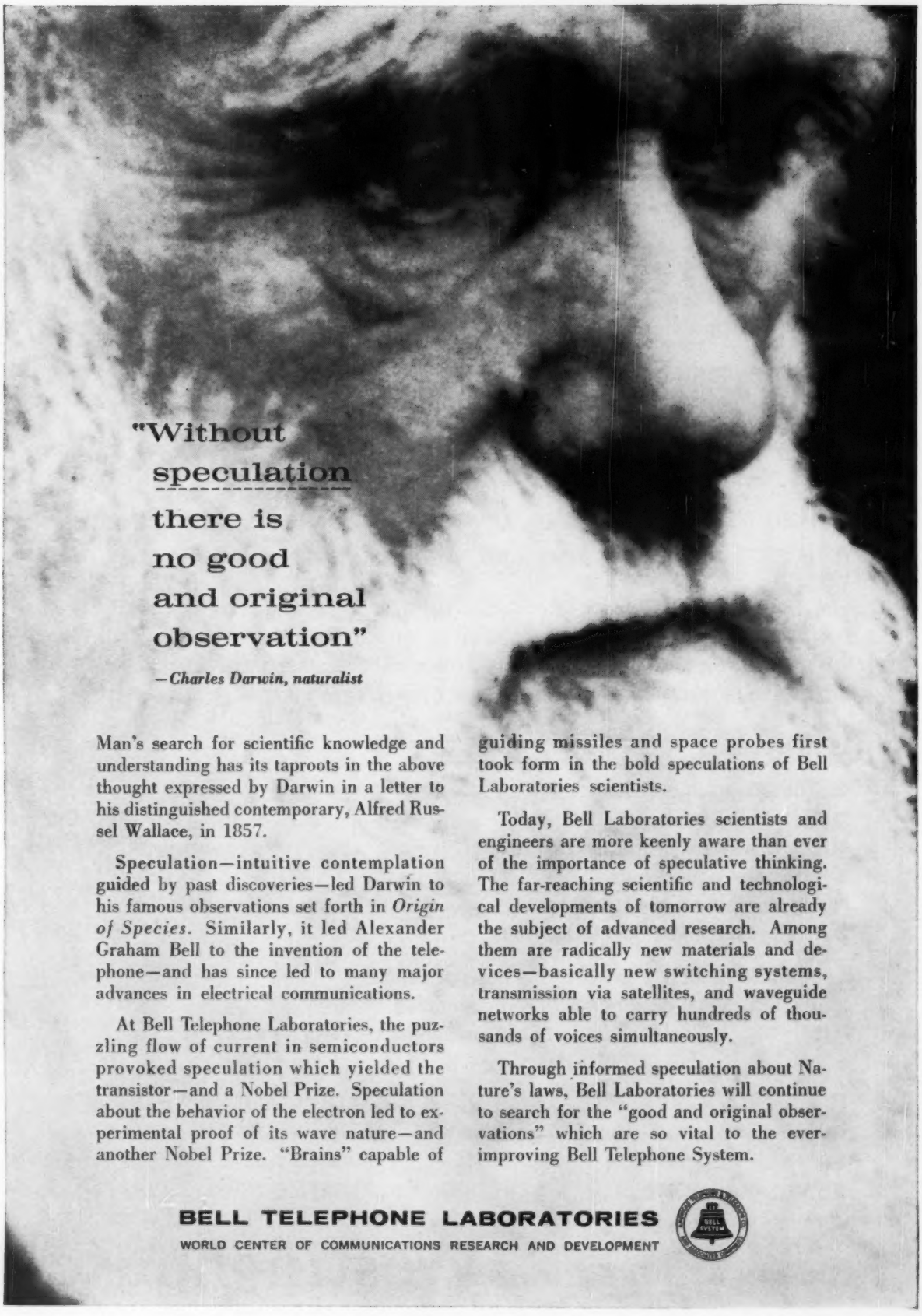


Man's search for scientific knowledge and understanding has its taproots in the above thought expressed by Darwin in a letter to his distinguished contemporary, Alfred Russel Wallace, in 1857.

Speculation—intuitive contemplation guided by past discoveries—led Darwin to his famous observations set forth in *Origin of Species*. Similarly, it led Alexander Graham Bell to the invention of the telephone—and has since led to many major advances in electrical communications.

At Bell Telephone Laboratories, the puzzling flow of current in semiconductors provoked speculation which yielded the transistor—and a Nobel Prize. Speculation about the behavior of the electron led to experimental proof of its wave nature—and another Nobel Prize. "Brains" capable of guiding missiles and space probes first took form in the bold speculations of Bell Laboratories scientists.

Today, Bell Laboratories scientists and engineers are more keenly aware than ever of the importance of speculative thinking. The far-reaching scientific and technological developments of tomorrow are already the subject of advanced research. Among them are radically new materials and devices—basically new switching systems, transmission via satellites, and waveguide networks able to carry hundreds of thousands of voices simultaneously.

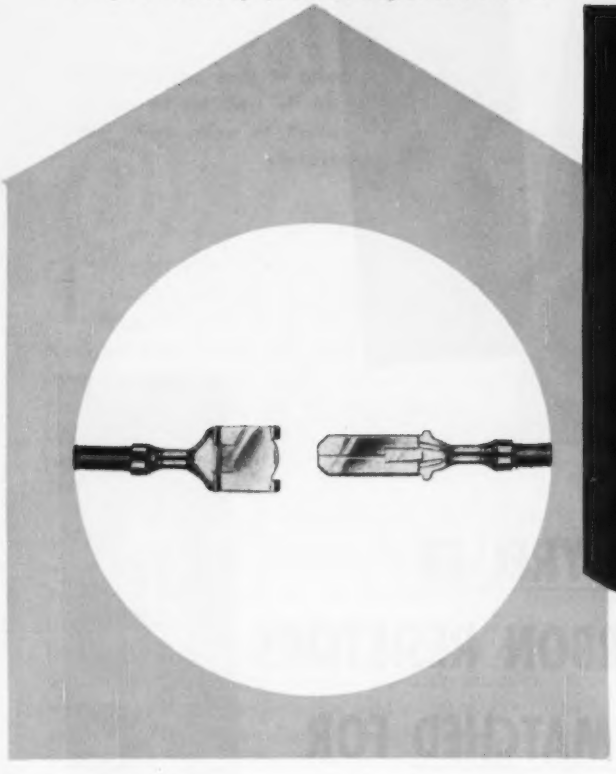
Through informed speculation about Nature's laws, Bell Laboratories will continue to search for the "good and original observations" which are so vital to the ever-improving Bell Telephone System.

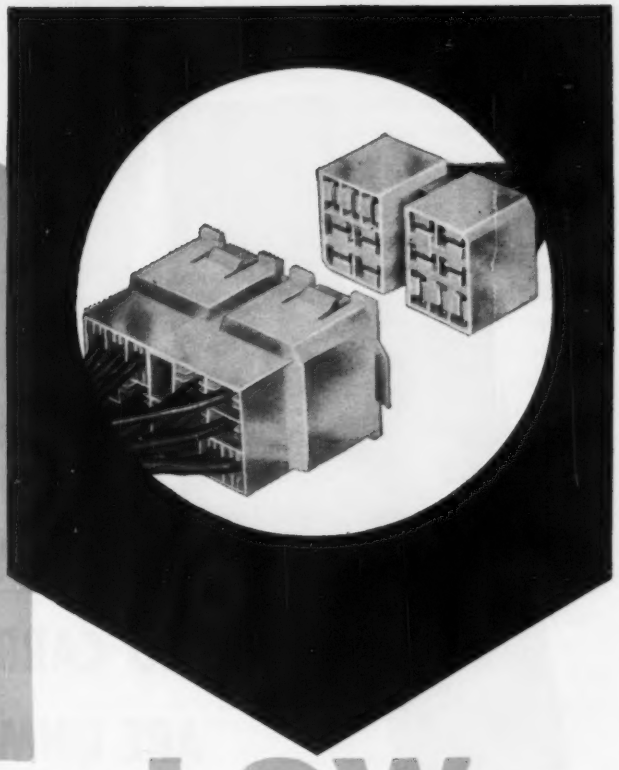
BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

HIGH

20-25 amperage rating for greater design flexibility . . . choice of 7, 14 or 20 way circuit blocks.





LOW

2-5 pounds insertion and extraction force for easier installation and servicing.

NEW AMPEEZ CONNECTOR GIVES YOU BOTH

Here is a workhorse of a connector! Housed in tough nylon and designed to carry as many as 20-circuits while holding insertion-extraction forces to 2-5 pounds, AMPEEZ Connectors are adaptable to many applications calling for a heavy-duty, easily serviced multiple-circuit disconnect.

AMPEEZ Connectors will match your application needs perfectly . . . anything you call for up to 20-circuits and 25 amps. One other major feature! *AMP's exclusive Tab-Gap Lok assures a constant contact pressure even under the severest vibration conditions.*

Use AMPEEZ Connectors, eliminate the human error in individual connections . . . make them fast and safe. Send today for AMPEEZ Connector literature and sample of tab and receptacle with Tab-Gap Lok.

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GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

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ALL UNITS ACTUAL SIZE

HYREL® FB
DEPOSITED CARBON RESISTORS ARE UNMATCHED FOR PERFORMANCE

★ ★

HYREL® FB DEPOSITED CARBON RESISTORS
are hermetically sealed in ceramic jackets against moisture and vapor... safely protected against mechanical abuse.
The Hyrel FB series is intended for applications in military, commercial and telephone equipment where long life under high humidity, small size, and stability of electrical characteristics are important.

WRITE FOR ENGINEERING BULLETIN 7010B
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00 MARSHALL STREET • NORTH ADAMS, MASS.

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The Model Law

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Some of the considerations which underlie the proposed revision of the 1946 Model Law for the registration of Professional Engineers are discussed.

THE MODEL LAW for the registration of Professional Engineers is being reviewed and revised. This is proceeding under the leadership of the National Council of State Boards of Engineering Examiners in co-operation with the National Society of Professional Engineers, the Founder Societies, and other engineering societies. This article presents some of the considerations underlying the proposed revision of the 1946 Model Law.

The purpose of a model law is to serve as a guide or model in preparing laws or changing laws in the several states. It can be used to indicate standards and procedures which are reasonable for the licensure or registration for the practice of engineering in order to safeguard life, health, and property and to promote the public welfare. A model law specifies the minimum requirements (education, experience, and examination) which are considered prerequisite to registration. Likewise, it includes certain specifications for administering the law.

Inasmuch as registration and licensing of persons to practice in a profession and in certain occupations is under the police powers of the individual states, each state has its own law. Engineering is not limited to political boundaries and if an engineer wishes to be registered in two or more states, registration procedures are much simpler if the minimum requirements in the other states are equivalent to those of the state of his original registration. Most state boards recognize the registration which was obtained under qualifications at least equivalent to those required in their state. The standards required by the National Bureau of Registration in order to obtain a Certificate of Qualification are high, so that most state boards recognize it as competent evidence for an engineer seeking registration in their state.

THE NEED FOR REVISION

THE QUESTION has been raised by many persons that since there are engineering registration laws in all the states and United States possessions, why should the Model Law be revised? Each profession should review and improve its standards from time to time. Unfortunately, the requirements in all states are not the same. With the larger scope of knowledge applicable to engineering, the standards for registration are made higher. The present thinking regarding minimum standards should be incorporated in the Model Law.

Some of the changes proposed raise the standards for registration and others are intended to clarify. Many on the committee have felt that the subject of registration of Land Surveyors should be covered in a separate Model Law rather than combined with Professional Engineers as it has been in the past. The arrangement of requirements for registration as proposed emphasizes recognition of registration in another state by endorsement and also endorsement of the Certificate of Qualification of the National Bureau of Engineering Registration.

REQUIREMENTS FOR REGISTRATION

THE PROVISIONS for certification as Engineer-in-Training (EIT) were first incorporated in the 1937 revision. The requirements for EIT are substantially the same except that the applicant who is not a graduate of an approved curriculum must have a minimum of 8 rather than 4 years of experience. This is consistent with the requirements for professional registration referred to below.

The working draft of the Model Law requires examinations for all applicants. Most states require a minimum of 4 years' qualifying experience following graduation from an approved 4-year curriculum. This is specified in the present Model Law. A few states require a lesser period of experience. The Model Law at present requires examination only for the applicant who has not graduated from an approved curriculum or where the experience evidenced by the graduate does not appear to the Board to be conclusive. However as minimum standards have been increased, 37 states now require examination as normal procedure for the graduate of an approved curriculum. The working draft of the revised Model Law requires 16 hours of written examination.

Again the Model Law and the state laws provide standards for a man who did not graduate from an approved curriculum. This requirement includes additional years of experience and an examination. The Model Law now specifies a minimum of 8 years of experience, which is only 4 years more experience than that required for the graduate of an approved curriculum. Since the approved curricula are at least 4 and some are 5 years, several states recognize that a man cannot work and in the same time learn the equivalent of what a full-time student can learn. Therefore, in several states the required years of experience have been

A special article recommended by the AIEE Registration of Engineers Committee.

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increased and the draft of the revised Model Law specifies a minimum of 12 years of experience for the nongraduate.

For the applicant who has a long-established practice with responsibilities and experience indicating competency, the working draft of the revisions requires an 8-hour examination.

COMPATIBILITY WITH BUSINESS ORGANIZATIONS

ANOTHER PROBLEM which the committees are trying to resolve is that of the forms of business organization which are compatible with the professional responsibilities of the engineer. Professional engineering judgment must never be superseded by that of a lay person, be he a client, an employer, or a business associate. Many in our profession feel that professional people cannot practice through a business enterprise, even if it is ancillary to their professional practice. Yet most concede that two or more professional engineers may form partnerships, or associate other professional engineers with themselves. Many would permit members of two professions to act as a partnership, as an engineer and an architect. Others might include a professional accountant or a financial expert.

Even though more than half of the professional engineers of the country are employed by corporations, a number of others feel that to recognize the practice of professional engineers acting through a corporate form of business jeopardizes professional standing. Engineering is ever more intensive and diversified. The complexity of many engineering projects require the skilled services of a large number of engineering specialists working together. Comprehensive projects, as for example those in chemical and nuclear developments, require such capital and other resources as well, so that the corporate form of business enterprise seems justified. However, certain restrictions may be necessary, inasmuch as it is essential that the public be protected by having the design and construction of projects under the final direction of the professional engineers.

The AIEE Registration of Engineers Committee has considered this problem, particularly in the light of paragraph 3 of the Policy on Registration adopted by the Board of Directors on June 8, 1957, and has suggested the following wording for consideration by the Model Law Committee:

> "No firm, partnership, corporation or joint stock association shall be registered or licensed to practice engineering in this state. Admission to the practice of engineering shall be determined upon the basis of the individual personal qualifications as prescribed by this Act. Any legal form of business enterprise may be utilized to provide the services of professional engineers as defined in this Act."

The registration of engineers and the work on the Model Law has served as a unifying influence over the years. Whereas 50 years ago most of the engineers questioned the need for or advisability of required registration, there has been an increasing feeling that the protection of health, safety, and welfare of the public requires the setting of standards for those who profess to be engineers. Thus, the registration of qualified engineers is of benefit to the public and to the profession, in that it prohibits the incompetent person from claiming that he is an engineer.

HISTORY

THE HISTORY of the many revisions of the Model Law indicates the growing acceptance of registration throughout the profession. The first Model Law in 1911 was prepared by a committee of the American Society of Civil Engineers and it was for Civil Engineers. The draft in 1915 was by a joint committee of six national societies. Other drafts were prepared in 1920, 1925, 1927, 1929, 1930, 1932, 1937, 1943, and 1946. The 1932 edition was adopted and endorsed by four national engineering organizations and by four state or local organizations and it was approved in principle by four others. Formal approval and endorsement was given by 8 national engineering organizations to the 1937 edition, by 9 to the 1943 edition, and by 13 to the 1946 edition. All five of the Founder Societies approved this 1946 edition. Although AIEE was represented on the committees at least since 1932, its formal approval and endorsement was first recorded for the 1946 edition. It is encouraging to have this evidence of increasing co-operation which promotes the solidarity of the profession.

The engineers of each state should study the Model Law when the revision is completed to see how their state law should be strengthened. Each state is of course autonomous, but the ideal would be to have the minimum requirements for professional engineers the same in each.

Again, it should be emphasized that in practically every state the registration is not in specialized branches but the engineer is designated as a professional engineer. The professional engineer is authorized to practice in any field in which he is competent, but professional ethics prohibit his practice when he is not competent. Although the fundamental purpose of requiring registration of engineers is to provide protection to the public, registration is also serving to enhance the professional standing of the engineer. We must review our standards from time to time to see that we are doing our part in providing adequate minimum requirements for registration.

Appendix

POLICY ON REGISTRATION OF ENGINEERS
(Adopted by the Board of Directors, June 8, 1957)

The American Institute of Electrical Engineers endorses and supports the registration of professional engineers as being in the best interests of the public and of the engineering profession, and recommends consideration of registration by its members.

In furtherance of this policy, the American Institute of Electrical Engineers:

1. Approves the objective of a Model Law, offers to cooperate with other sponsoring groups in revisions subject to

approval by the Board of Directors, and offers its assistance in the appropriate revision of registration acts where responsible organizations request such assistance.

2. Supports the objectives and activities of the National Council of State Boards of Engineering Examiners and offers advice and assistance when requested.

3. Recommends that there be no discrimination, directly or indirectly, as to the form of business organization under which the practice of engineering is conducted provided that the person or persons in responsible charge of such practice be legally registered professional engineers.

4. Recommend that each Section appoint a committee or representative to co-operate with the State Board of Engineering Registration or other appropriate agency in the dissemination of information concerning registration in its state.

5. Recommends that Sections sponsor or co-operate with other groups in sponsoring refresher courses as preparation for written examinations.

6. Recommends that, upon request, committees and qualified individual professional engineers co-operate with state Boards of Registration in the development of adequate written examinations.

7. Recommends that each Student Branch devote time to the subject of professional development with special emphasis on the purpose of registration, the standards required, the Engineer-in-Training Program, and the procedure in applying for registration.

8. Recommends that the Committee on Registration of Engineers annually sponsor a short informative article on registration of professional engineers to be published in *Electrical Engineering* at an appropriate time.

9. Recommends that the Committee on Registration of Engineers make available annually a pamphlet giving up-to-date sources of information in the various states and other information of value to students and other candidates for registration.

Computed Confidence for Aero-Space Transportation

D. S. BASSETT

A discussion of the effect of space transportation problems upon the system design engineer, the role of reliability, and the contribution that the support engineer can make through use of computer-controlled test and checkout from factory to launch. In addition, the postlaunch use of prelaunch data will be discussed.

SPACE transportation is a complex problem for many reasons, but the four that predominate are the following: (1) long operating life, (2) high cost of acceleration of each pound, (3) unfriendly environment, and (4) unattended operation.

The space transportation problem considered here is primarily one of travel to other members of our solar system rather than near-space trips between earth points. The velocities attainable in the near future compared with the distances to be covered account for the long operating life problem. The present and near-term boost methods are extremely expensive (Fig. 1). Every pound of equipment in the space vehicle is precious, and high-performance designs will be very attractive. Unfortunately, high performance and high reliability are very difficult to achieve at the same time.

Couple unfriendly environment and long operating time with the extremely high cost of transporting a pound of material, or, more correctly, accelerating it to the required velocity to permit it to travel through a desired flight path, and the system design problem becomes even more acute. To minimize the energy cost, each item of equipment in the vehicle must be depended upon to work constantly throughout the entire flight within its design specification. The problem of long life can be solved by (1) selecting high-quality

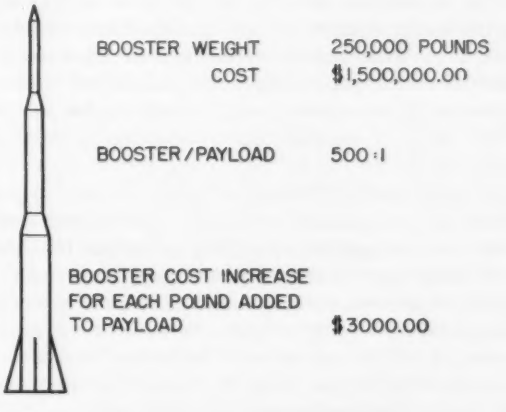

Fig. 1. Typical multistage vehicle.

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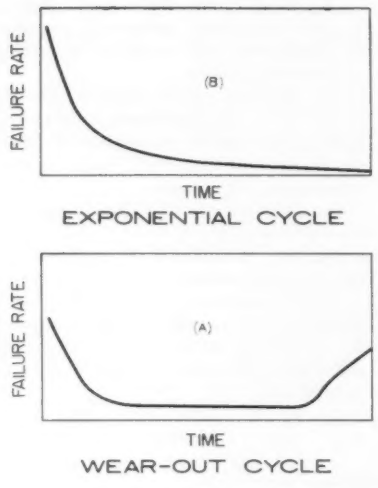
Fig. 2. Failure cycle.



components, (2) derating components in critical circuits, and (3) applying redundant design. All of these methods tend to penalize equipment by increasing its weight and part count, and it is more expensive to build and accelerate a derated and redundant system.

The failure of individual components occurs through a wear-out or exponential decay cycle. The wear-out cycle is characterized by a period of low-failure rate prior to a predictable end-of-life (Fig. 2A). When no wear-out point has been defined, failure occurs within a population of components at a rate that decreases exponentially with time (Fig. 2B). In either case, the time of failure of individual components is not predictable. All failures are undesirable, but unpredictable or random failure can be catastrophic in space transportation systems. Design procedures to cope with predictable failures at a wear-out point are straight forward and their effect upon the system is under control. Random failures of either class must be detected before launch, to insure high confidence in the performance of the space vehicle.

SUPPORT ENGINEER CONTRIBUTION

THE CONFIDENCE one has in a piece of equipment is usually based upon many intangible experience-related factors. A quantitative expression of confidence is essential to the prediction of the chance of successful operation of aero-space transportation systems.

The support engineer can contribute to the confidence in the system by employing test and checkout techniques that (1) minimize system design requirements for test and checkout, and (2) maximize failure prediction and prelaunch failure detection. He should avoid techniques which depend upon the system designers to include many test points to permit test and checkout of the space vehicle. A requirement for test points in addition to normal input and output connections introduces a design trend which diverges from the goal of low weight and high reliability.

The system engineer finds that he is forced to use a more complex circuit to provide test access and continue to accomplish the original function in a reliable manner. The increased weight and space required may cause a decrease in design safety factors to allow original payload limits to be met. There are many ways that added design requirements interact to complicate the original design problem. This interactive process culminates in a divergence from original goals of reliability and weight.

Even though the intrafunction test points have undesirable side effects, it must be recognized that some points are needed to permit the location and repair of unpredictable failures prior to launch. In this manner, they contribute to the final operational reliability of the system, and a portion of the losses resulting from increased design complexity is regained.

A less obvious but important effect is the turmoil that testing requirements create in the mind of the prime equipment designer. His primary concern is the design and development of high-performance operational hardware, and he considers intrafunction test access another boundary condition which compromises his circuit design. Consequently, inclusion of intrafunction test points are resisted by most system designers, and often they must be added at a time when the penalties to the design are extreme.

The magnitude of the system design problems increase with each new space venture. Generally speaking, the time required to reach a satisfactory technical solution increases in phase with the growing number of interacting system requirements. One approach to holding constant the design-cycle time or to shortening it, is to reduce the number of interacting requirements between system performance and support requirements. It must be emphasized that test and checkout should complement the work of the system designer rather than impose additional problems and restrictions.

The reduction of design interaction and the use of automated testing for aero-space transportation equipment may seem to be diametrically opposed objectives. These objectives are in opposition if automation is achieved by mechanizing step-by-step testing methods and imposing a requirement for many test access points. On the contrary, the use of high-speed computing equipment promises the possibility of conducting test and checkout of the required quality with a significant reduction in interaction (access requirements). The testing and checkout for fault detection and isolation by computer control is based upon the analysis of a discrete set of dependent variables which describe a given function in the system.

Since the choice of testing methods can effect the degree of prime and support-system-design interaction, a discussion of these alternate approaches is in order.

PRELAUNCH FAILURE DETECTION METHODS

THE COMMON METHOD of arranging the test sequence of a system, or an individual unit of a system, is to construct a fault detection and isolation tree. The technician or engineer performs a series of logical measurement/decision steps to locate the offending

element or elements. By its very nature, the fault tree requires a step-by-step process which amounts to (1) data-taking by measurement or observation, (2) a comparison of the data with a given set of limits, and (3) a decision which leads to the next step based on this comparison. This process is repeated over and over until the problem area and elements are located.

The automation of the steps of a fault detection and isolation tree is not difficult, once the required test access is provided. A number of programmer-comparators have been developed and are currently available for this purpose, and the performance requirements imposed upon the programmer-comparator design are not great. The speed of progress through the fault-tree steps toward a solution is usually governed by the circuit stabilization time, filling rate, precession rate, or some other dynamic characteristic of the system. By the time the test access has been designed into the system, the only design problem of any real consequence that remains is the design of adaptive equipment. The equipment is used to normalize test inputs and outputs between the system and the programmer-comparator.

The drawback to this type of testing procedure stems from the fact that a data source must be found between each of the segments of the circuit which is to be isolated, and the data source must be normalized to the particular programmer-comparator. The data should be independent of other circuit conditions so that an unambiguous decision can be made. Generally, these data points are in addition to the normal signal flow which must exist for system operational purposes. If fault detection and isolation are performed in this manner, the design divergence problem mentioned earlier will exist because the bulk of the design problems associated with the automation of tests exist in the prime system where design interaction is acute.

An alternate method for fault detection and isolation depends upon the analysis of a dependent set of measurements used to define a function. Maximum use is made of the measured data and a reduction rather than an increase in test access is the goal. The ultimate goal of this method is to require no more data flow for testing than is required for normal system operation. Test data would be obtained by monitoring normal signals that are flowing between units in the system. Monitors on interunit connections would not constitute the addition of test points, whereas the interruption of signal flow within a unit itself would constitute the addition of test points. Since signals must flow between units to perform their normal function, it is reasoned that observing these signals as they flow is a relatively inexpensive and easily obtained piece of test data. The inclusion of internal test points requires a more careful analysis on the part of the original system designer to be sure that these points are located properly, and, secondly, that they did not disrupt signal flow to an extent that proper operation of the unit is affected.

The dependent variable measurement method requires the use of a computer controller which has temporary memory and may be programmed for deductive logic. The number of dependent variables which must be analyzed for any particular function determines the actual performance requirements. The information must be stored and then integrated with the other dependent variable measurements and assessed as a whole. All parts of the stored instruction for operating on the dependent variable measurements must be available rapidly to permit the selection of the correct set of subroutines. The prime and support designs become less interactive because most of the difficult problems associated with automatic testing occur outside of the prime system, since they are concerned with the effective processing of limited data.

Admittedly, use of computer control for testing is not widespread, and there are only a few applications to equipment that exist at the present time. Actually, computers have performed this function for themselves for some time. Almost all high-speed digital computers in use today have, as part of their basic operation, self-testing routines which do test their computing capability by computing. Examples of system testing with some fault isolation to the unit level can be found in the *F-106/MA-1* weapon system. The digital computer in that system is used to manage a large portion of the preflight testing and some of the dock or periodic testing of that system. More recently, both the *B-70* and the *F-108* weapon systems were scheduled to have extensive testing managed by their respective computers.

Preliminary studies have been completed by the U. S. Army at Frankford Arsenal which have shown application of computer controlled checkout to individual units of a system.[1] Fault isolation to all circuit components has been demonstrated with very limited test access beyond the input-output connections. These studies imply that computer-controlled automatic testing can be used to isolate faulty resistors, capacitors, and other components of this class in the shop, depot, or factory.

Only a few computer-controlled automatic testing systems have been assembled to date. As mentioned earlier, much of the early work has been done with digital computers that were basic subsystems of major weapon systems. The reliability and environmental requirements that have been met by these designs provide a solid base for their application to automatic support systems designed with the specific problems of fault detection and location in mind. Such a system has been built at the Hughes Aircraft Company.

FAILURE PREDICTION APPLICATION

THE COMPLETE ELIMINATION of faults prior to launch in addition to the use of high-quality components may not result in an operational reliability that meets the mission requirements. Some form of redundancy may be the only path remaining for the system designer. Simple parallel paths help, but it would be more effective to hold a parallel path out of service until the original path is predicted to be undependable. The logic required to switch at an optimum time requires extensive backup information.

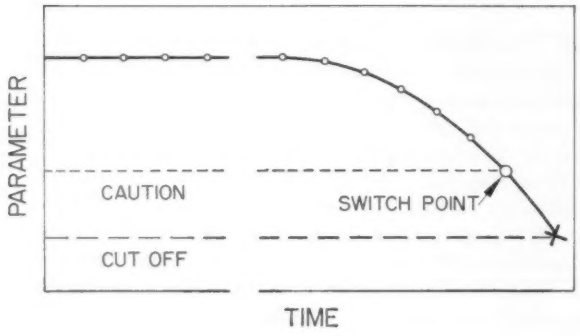


Fig. 3. Failure-characteristic equation.

A basic understanding of the failure trends in components is the first requirement. Considering components as systems should aid in the search for failure trends. When a failure trend is isolated for an electronic part, it can join the group considered to have predictable failure characteristics. Numerous studies have been and are being conducted to establish failure-characteristic equations. Once these equations are known, a monitoring program will be required to collect data, prelaunch and postlaunch, from which current operating trends can be correlated with failure-characteristic equations (Fig. 3). By proper correlation, a decision of switch to a spare path can be made during a period of acceptable operation of the original path.

It might seem that collection of data for failure-characteristic equation trend analysis would require extended prelaunch operation of the equipment. At the present time, many hours of operation occur which are wasted from a predictive point of view. All operation of the system from initial factory installation tests until launch could be monitored. These data would be used to predict failure in all of the components for which failure characteristic equations have been defined. A broad application of computer-controlled test and checkout equipment at each step in the factory-to-launch sequence represents another opportunity for the support engineer to contribute to mission success.

The failure prediction information could be used as a basis for replacement of defective equipment before launch and to circuit path switching after launch. A partial step toward including the capability for monitoring, decision making, and switching to alternate paths in the space vehicle would be to preset a switch time—based on prelaunch trends. A further step would be to monitor data during flight and switch at a time based upon enroute operating trends. All of these techniques point out the necessity of recording and analyzing data in a sophisticated manner, and indicate that the capabilities required of such a data processing system will be extensive.

To sum up: the problems that are presented by space transportation increase the importance of complementary efforts by system and support-design engineers. A support program which reduces the interaction between the system design and the support design can be a major factor in the success of space systems.

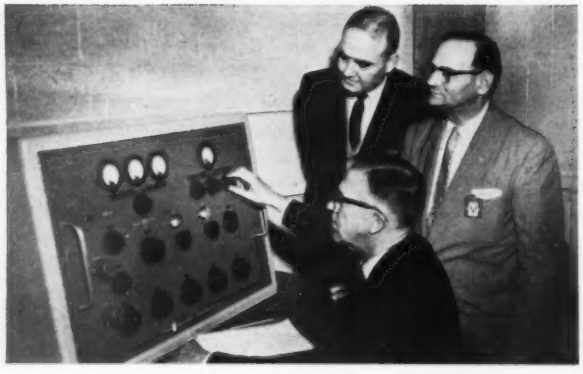
The support engineer can reduce design interaction by: (1) minimizing access requirement for test and checkout, (2) detecting and repairing all prelaunch failures, and (3) organizing an effective failure-prediction program using factory-to-launch and enroute operating-trend data.

The use of computer-controlled automatic test equipment appears to be a promising method for implementing the support engineering contribution to space transportation system success.

REFERENCE

1. Frankford Arsenal, Use of Computer Controlled Checkout Equipment for Detailed Fault Diagnosis, E. B. Quinn, Third Annual Joint Military-Industrial Electronic Test Equipment Symposium, vol. I, 16, 17, 18, Sept. 1959, pp. 97-125.

EHV Bridge



Members of a committee for the "Cornell Project" examine unique new Schering Bridge that Cornell University will use to test new types of extra-high-voltage underground cable for the utilities industry. Project consultant E. H. Salter of Electrical Testing Laboratories, New York, N.Y., operates the bridge, while project engineer J. L. Rosson (*left*), associate professor of electrical engineering at Cornell, and C. S. Schifreen, cable and insulation research engineer with Philadelphia Electric Co., observe. The bridge is a development of Leeds & Northrup Company for measuring the insulation properties of high-voltage cables and is the only one of its kind and rating available in this country.

Pilot-Wire Protection of Transmission Lines

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FELLOW AIEE

THE PRESENT pilot-wire protective systems for transmission lines employing leased pilot-wire circuits are an outgrowth of conventional differential protective systems for other types of electric apparatus. Thus, these line-protective systems are characterized by the fact that the pilot wires are part of the differential connection between the current transformers at the line ends. The pilot wire has distributed shunt capacitance as well as series resistance, with the result that when these parameters reach sufficient magnitude, attenuation and undesirable phase shifts occur in the pilot-wire circuit. Thus, the system may be prevented from functioning correctly under certain operating conditions.

In the system to be described, the pilot wires are used only to transfer information simultaneously from each end to the opposite end, and the differential connections are established locally, one at each end. Therefore, the electrical characteristics of the pilot wire enter the picture only in so far as they introduce signal attenuation and phase shift in the transmission of the information. The attenuation may be compensated for by the use of amplifiers, and the phase shift by suitable design of the associated circuits.

Because of the voltage and current limitations of leased pilot-wire circuits, all pilot-wire systems of this type derive voltages from the currents at each line terminal, and form the differential circuit from them. Fig. 1 shows schematically the protection of a 2-terminal line where the voltage V_1 is thus developed at one terminal by the flow of the three secondary currents through a network designed to produce a voltage which is present under load and all types of faults. The voltage V_2 is similarly developed at the far end of the line by the secondary currents there.

Considering the pilot-wire circuit shown, it will be seen that this circuit is terminated at each end in an impedance Z_0 which is made equal to the characteristic impedance of the pilot-wire circuit. The voltages V_1 and V_2 are introduced into the line by means of 1:2 ratio bridging transformers with center-tapped secondaries.

The voltage $2V_1$ introduced by the bridging transformer sees an impedance on each side of Z_0 or a total of $2Z_0$, and since the circuit is balanced, no voltage will appear at the point indicated as E_1. At the corresponding position at the far end of the line indicated as E_2, however, a voltage will appear which is given by

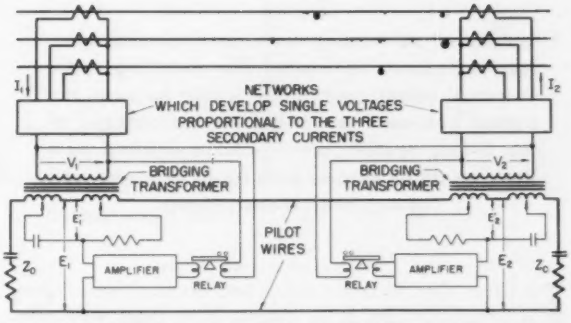

Fig. 1. Basic pilot-wire circuit employing bridging transformers showing application to conventional percentage-differential relays.

$$E_2 = \frac{V_1}{\cosh\theta + \left(1 + \frac{Z_0}{Z_s}\right)\sinh\theta} = \frac{V_1}{A} \text{ volts} \qquad (1)$$

where θ is the hyperbolic phase angle of the line, which is directly proportional to its length, and Z_s is the impedance connected across E_2. This impedance is necessary for purposes of measurement and may be kept at a relatively high value.

As previously indicated, the differential connections must be established locally at each end. Thus, at the E_2 end a voltage E_2' may be developed from the bridging transformer by means of an RC network arranged so that

$$E_2' = -V_2/A \text{ volts} \qquad (2)$$

The sum of the voltages E_2 and E_2' represents the differential effect, and this may be applied to a suitable amplifier to drive the operating coil of a percentage-differential relay. The restraining coil is fed from the voltage V_2.

With suitable modification of this basic circuit, the system may be applied to present pilot-wire protective relays, or to relays specifically designed for the purpose.

For the protection of a 3-terminal line, a voltage developed from the currents at the tapped station is placed in series with the pilot-wire circuit between the end stations at its mid-point. If the network supplying this voltage is designed to give it the proper attenuation and phase shift with respect to the output of the networks at the end stations, it may be shown that the relay system described with the proper phasing of connections will function correctly at the end stations, and that the pilot-wire current at the mid-point is indicative of the differential effect at the tapped station. The mid-point of the pilot-wire circuit may be established by running the pilot wires from the ends to the tapped station and padding out the shorter line.

Digest of paper 60-155, "A New Approach to the Pilot-Wire Protection of Transmission Lines Using Leased Pilot Wires Having Relatively Long Electrical Characteristics," recommended by the AIEE Relays Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Jan. 31–Feb. 5, 1960. Published in AIEE *Power Apparatus and Systems*, June 1960, pp. 245-52.

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Microwave by Pole Line

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Instead of developing more sophisticated wireless techniques to exploit the shrinking radio communications spectrum, it would be wise, the author believes, to ponder the advantages of the G-Line system, which utilizes existing pole lines, as an r-f carrier, both for its economy and operational characteristics.

In these days of radio relays and horizon techniques, it requires courage to discuss pole lines and especially microwave by pole lines.

Is this return to wire technique not a step backwards?

It is not, if we recognize history (technologically and otherwise) not as a single stream of events but composed of a number of streams crossing and often reversing on each other. How else could we explain the present reversion to crystal techniques after vacuum tubes had become so generally accepted. Thus, the recent development of a simple yet efficient single-wire waveguide—the surface wave transmission line or G-Line—may well herald an essential addition, if not an effective competitor, to radio transmission systems.[1]

Yet, just as it took the new crystal devices more than 15 years to enter the market, this simple yet fundamentally novel transmission technique will require extensive demonstration and co-operation between pole owners and manufacturers of wire and equipment to insure the general acceptance it deserves. The market is there.

Public utilities and especially railroads and power companies are in a position to exploit their extensive pole plant to carry broad-band communications not only for themselves but also for others. Power transmission systems could even use their ground wires as a G-Line for r-f carrier transmission.[2] Each G-Line strung over the country presents a new airway not controlled by the Federal Communications Commission (FCC).

Transcontinental G-Lines may link New York and San Francisco, and an inter-American communication highway may connect North and South America and one day, perhaps, the Americas may be linked over Asia with Europe. Compared with the simplicity of world-wide broad-band transmission over a single wire and over poles readily available, global transmission planning by radio relay, whether earthbound or space traveling, appears farfetched, complex, and costly.

However, in order to utilize the great potential residing in this G-Line, it will be necessary to broaden our concepts and to get rid of certain restrictive notions.

There is a great deal of uniformity, almost conformity, in the development of techniques. In the technique of communications this uniformity results in a certain rigidity of fundamental concept, lack of originality rather than lack in performance. While we could be satisfied with our economic success, we should be more flexible in the techniques by which we achieve this success.

POINT-TO-POINT VS. CONTINUOUS TRANSMISSION

What appears to guide present techniques is a rigid trend into space, the trend to get away quickly from one place to another, either in person or in word. It is a trend to fly and a trend to radio; a trend toward individual transportation and the neglect of public transportation; the overstressing of highways and airports, and the neglect of our commuters.

This emphasis upon point-to-point superstructures not only rigidifies our national habits, it also fails on an international scale to be successful or even to impress. No wonder few people abroad, in communication-wise and transportation-wise underdeveloped areas, are interested in super highways, horizon communication, and television when roads, electricity, telephone and telegraph are still missing.

WIRE VS. WIRELESS

This rigidity in technique becomes readily apparent when we examine the development of our communications.[3]

Until about 1946, open wires carried low frequencies up to 200 kc, and coaxial cables of the *L-1* system carried radio frequencies and utilized up to 600 channels.

Between 1946 and 1953, cables while already competing with radio, advanced to 1,800 channels in the *L-3* system.

Then development of cable stopped and radio took over in the form of 35- to 34-mc and 152- to 162-mc mobile radio systems. By 1948, the *TD 2* system extended radio relays into the 480-channel 4-kmc (kilomegacycle) range; by 1958, the *TJ* system advanced to 11 kmc with 240 channels. For 1960 we are promised the *TH 6*-kmc radio relay with 1,800 channels.

Simultaneously, we notice tropospheric scatter systems in 1957 extending from Florida to Cuba on 870

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Theodore Hafner is with Surface Conduction, Inc., New York, N. Y.

The author acknowledges a great debt to the New York Central Railroad and the Anaconda Wire and Cable Company. A few of the many who helped are: R. B. Steinmetz, Anaconda; B. Van Wagner, Anaconda; and J. L. Niesse, New York Central. A special debt of gratitude is extended to R. C. Karvwatt, director of communications, New York Central whose initiative was instrumental in applying the new medium to specific railroad conditions.

mc, and in 1959 from Florida to the Bahamas on 2 kmc.

Then radio developments appeared to stop; we are now being promised in circular waveguide, a hollow tube carrying 200,000 channels.

There was a gap in cable development around 1950 and a similar gap around 1960 in the development of radio. While the first gap is being bridged by radio of increasing carrier frequencies, the second gap appears unbridged. How are we going to feed 200,000 channels?

FROM OPEN WIRES TO WAVEGUIDE

SINCE THE CIRCULAR WAVEGUIDE marks a return to physical transmission lines, why not other transmission lines?[4]

The development of physical communication tools for private rights-of-way, in contrast to the public point-to-point airways, is closely tied to pole lines. When pole space became short, phantom and low-frequency carrier circuits helped to bridge the gap, but here development stopped. No attempts were made to adopt new high-frequency and microwave techniques to pole lines.

Symmetrical lines, while forming high-frequency carriers, are weather sensitive and used mainly as short-distance antenna feeders.

Asymmetrical lines, such as co-axial cables, will transmit r-f carriers over a wide distance but there, too, at higher frequencies, loss and inhomogeneity are prohibitive.

Thus, omitting the inner conductor and developing the coaxial cable into a hollow tube of very low loss, must be considered an important advance in broad-band technique, although greatly offset by complexity and expense of installation.

THE G-LINE

EVEN MORE IMPORTANT, therefore, appears the ingenious omission of the outer conductor by Dr. Goubau which leaves the inner conductor with a closed cylindrical field of low loss and broad bandwidth: a simple insulated wire which can be easily installed and connected (Fig. 1).[5]

In order not to disturb the field around this wire it is only necessary to support it at a short distance from the pole arms, for example on V-shaped nylon loops and trollies such as used in the Helena television or New York Central test G-Lines or, as in West Germany, on rigid support rods made of a polyester resin with Fiberglas inserts.

In order to connect to standard r-f transmitters, receivers, and amplifiers serving its frequency range, the G-Line and its field are received through a conical horn which can be coupled to a standard 60- or 75-ohm coaxial cable.

While the horn coupling is particularly simple and efficient, it is also possible to transmit to and receive from a G-Line wave without physical contact; for example with a short section of another G-Line of the same dimensions.

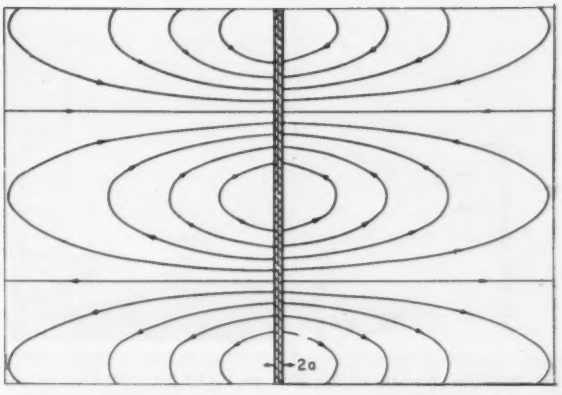

Fig. 1. Surface wave field

OVER-ALL LINE LOSS

HORN AND SUSPENSION LOSSES of typical long distance vhf G-Lines are about 4.5 db per mile (3.5 db for railroad) somewhat lower than the wire loss itself, which for a no. 6 wire is about 6.5 db per mile.[6]

The total loss of such a G-Line system, therefore, is about 11 db per mile (slightly lower for railroads: 10 db per mile).

The losses of larger diameter G-Lines decrease relatively slowly and the over-all loss is not sensibly increased by rain, snow, thaw or frost, except wet snow or water ice of extended thickness; transient conditions are compensated for by the usual amplifier gain control.

PRACTICAL APPLICATIONS

WITH ITS LOW LOSS, broad bandwidth and simple construction and suspension, the G-Line effectively competes over short distances with cable and waveguides, and over longer distances with cables as well as radio links.

An antenna feeding line, for example, 1,000 feet long at 500 mc, will cost about 15% of the cost of a co-axial cable of equal loss. It may also be mounted more cheaply, either suspended from the transmitter building or run along one side of the tower (Fig. 2).[7]

Operating range of different G-Line models extends to 10,000 mc.

At medium distance in booster and satellite antenna systems, G-Lines serve to connect receiving and transmitting antennae of the same frequency and to form drop-offs from radio relays, and from generally any type of antenna connection (Fig. 3).

LONG-DISTANCE, LOW POWER

THUS, IN THIS COUNTRY, as well as in Germany and now in England, community television is proving to be a successful example of long-distance G-Line application.

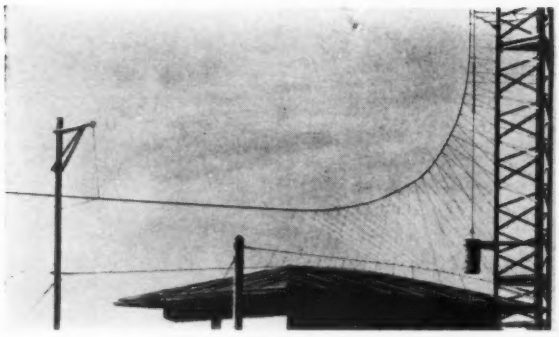

Fig. 2. G-Line feeding 10 kw, 500 mc to FM transmitter of Federal Broadcasting Station, Munich, West Germany. Manufactured by Rohde & Schwarz, Munich.

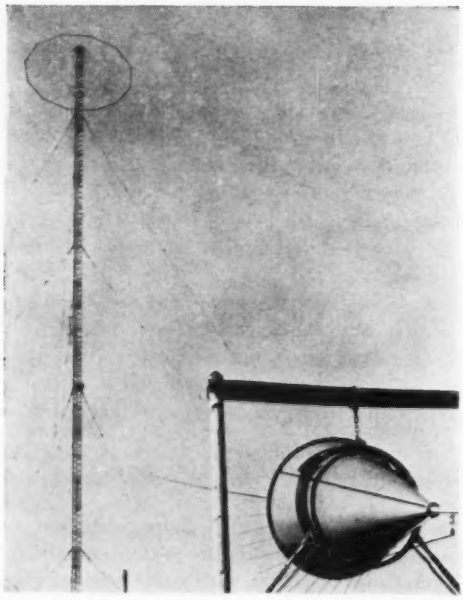

Fig. 3. G-Line system for 10 kw, 500 mc for Federal Broadcasting Station, Munich, West Germany. Manufactured by Rohde & Schwarz, Munich.

Fig. 4. New York Central G-Line termination horn, Nepperhan Station.

The G-Line with its low loss reduces the number of amplifiers to a fraction of those required for cable and, therefore, with the same equipment reaches much further.

A system of, say, 20 amplifiers each of 60-db gain, will carry a coaxial cable over a distance of about 8 miles; a no. 6 G-Line over 80 miles.

Such performance makes the G-Line not only practical wherever FCC channels are unfeasible, or unavailable, but also in view of its large band width, competitive with radio links.

NEW YORK CENTRAL DETAILS AND COST

In this respect our experience with the New York Central G-Line will be of interest.

This latest G-Line was built (as a test line) by the New York Central Railroad last year in co-operation with Surface Conduction, and Anaconda Wire and Cable which supplied the wire, a no. 6, 40% Copperweld, polyethylene coated according to our specifications.

This G-Line extends along the Putnam Division over a distance of 4.5 miles.

It starts in Westchester County at Nepperhan (Fig. 4), where a 100-foot *RG11U* cable connects the station building to a horn arranged on a pole on the other side of the track, and from there the wire runs without interruption to Ardsley Station where it connects over a second horn to another 100-foot cable.

The G-Line is mounted on the lowest cross-arms. Distance from ground varies between 5 and 20 feet (Fig. 5). Distance from other objects such as wires, poles, pole-arms and brushwork was usually held to about 3 feet but not less than 2 feet. The line crosses the track at several points and there are numerous corners and curves.

Large corners were reduced by trolley-type cross brackets (Fig. 6).

At a number of points the wire runs closely above wires, roofs, and bridges and also beneath bridges (Fig. 7).

In spite of this, the loss characteristic is quite regular and is as low as expected from theory, experiment, and previous experience (Fig. 8). Total loss is about 45 db or 10 db per mile; and without intermediate amplification 4 television channels were transmitted simultaneously, 2 channels in each direction, with the aid of Blonder-Tongue equipment and on channel frequencies corresponding to television channels 12, 10, 8, and even 6.

There is every reason to assume that telephone, teletype and other channels will be carried over the G-Line equally well and in the large quantities permitted by the available bandwidth.

In fact, recently in Paris, the writer talked by telephone over a G-Line of similar dimensions built by Lignes Telegraphiques et Telephoniques.

In the New York Central G-Line, the cost of installation was also found to be as low as expected, and even considerably lower than in the Helena G-Line.

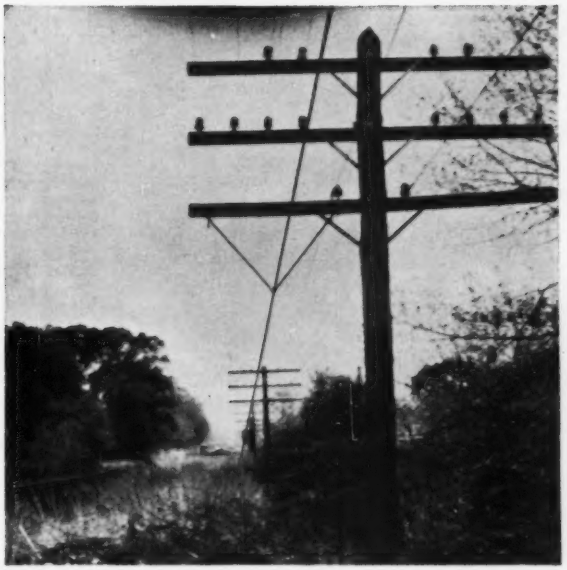

Fig. 5. New York Central G-Line standard suspension on nylon loop.

In Helena, a no. 8 wire required 8 amplifiers over a distance of 14 miles. In the New York Central, with a no. 6 wire 4½ miles long, no amplifier was required.

The New York Central G-Line was built by an otherwise uninstructed line crew of five men which laid the wire under extremely adverse weather conditions, in the heavy snow prevailing in the first days of March 1959. It took them about five days, a little more than 1 mile per day. This is due to the fact that the tolerances in suspension methods and dimensions are rather large.

J. L. Niesse, general superintendent of communications of the New York Central Railroad, who personally observed the G-Line in construction as well as operation, stated his belief that 2 miles of G-Line could be built in a day. This would bring construction cost down to about $110 per mile, and a complete G-Line installation to less than $600 a mile, which may be further reduced by using a lesser percentage of copper, such as 5% copper-plated steel wire as manufactured by the National Standard Company.

Thus, the New York Central installation confirms the economy of long-distance transmission by G-Line along railroads (the few television channels of course did not nearly exploit the broadband properties of this installation. Its 100-mc bandwidth could easily take care of 10 television channels and several hundred voice channels, without changing the existing pole or mast installations.

DECOUPLING AND COUPLING

With the indicated suspension conditions the G-Line is not affected by, and does not affect, other communication wires. Cross talk between G-Line and bare wire is very small because the phase velocities of the respective waves are very different. Mounted on telephone poles, therefore, the G-Line may have a distance of about half a wave length and even less from the other wires.

External disturbances such as those due to ignition were not observed either in Helena or in Westchester in spite of the fact that both G-Lines run close to a principal highway.

For better exploitation of available pole space, several G-Lines may be arranged in parallel. In case these different G-Lines have waves propagating in opposite

Fig. 6. New York Central G-Line corner suspension by nylon trolley.

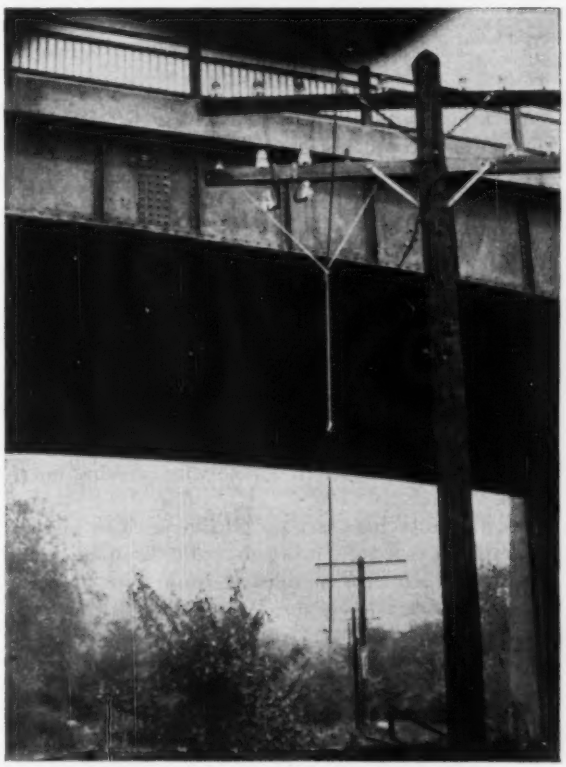

Fig. 7. New York Central G-Line passing beneath bridge.

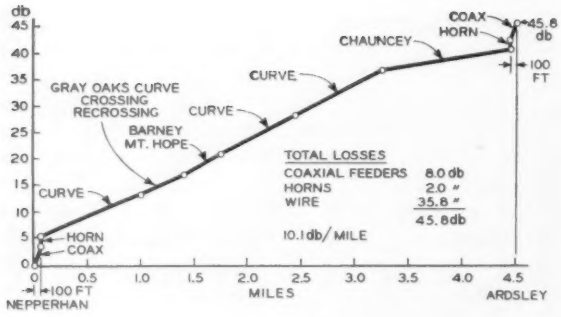

Fig. 8. New York Central G-Line loss characteristic—Nepperhan-Ardsley, 4.5 miles.

directions, cross talk will also be small because of the great difference in phase velocity.

However, with waves being propagated in the same direction along two close G-Line wires, intercoupling may occur. This intercoupling may be reduced by changing the relative dimensions of the G-Lines, thus making their respective phase velocities different.

On the other hand, intercoupling may be encouraged and waves may be transmitted and received between parallel G-Lines.

With proper dimensioning of the field radius of a stationary G-Line and with appropriate means mounted on locomotives or cars, G-Line signals may be picked up by the moving train, which in turn may communicate with receivers located along the line (Fig. 9); all this without exceeding the radiation limits imposed by the FCC.

OUTLOOK

THERE IS NO REASON why a system such as the New York G-Line could not be extended over any existing poles and, by continuous amplifications every 4 miles or so, to any desired distance.

Not all this of course will be G-Line; we still require r-f relays jumping mountains and bridging waterways, coaxial terminations and underground wiring. But the possibility of utilizing the large networks of pole spaces existing all over the world, the idea of having the same poles carry a hundred times as many telephone and telegraph channels as they do now, the plan of saturating vast underdeveloped areas with voice and television channels, all this is brought close to realization by a unique combination: a pole wire carrying microwaves.

It will also be necessary for all interested in physical transmission, especially railroads, power companies, and pipelines which own or operate continuous rights-of-way, to further actively the development of communication techniques using these rights-of-way. Long-distance systems cannot be manufactured in a factory or demonstrated in a showroom or over the counter. Such systems, in order to be demonstrable, must be physically installed and operated.

It is quite obvious that this type of co-operation must be continued and expanded. This is not merely a matter of increasing the value of pole space, of real estate; it involves the planning and building of mass information highways fundamentally different from (even though connected to) existing radio transmission systems.

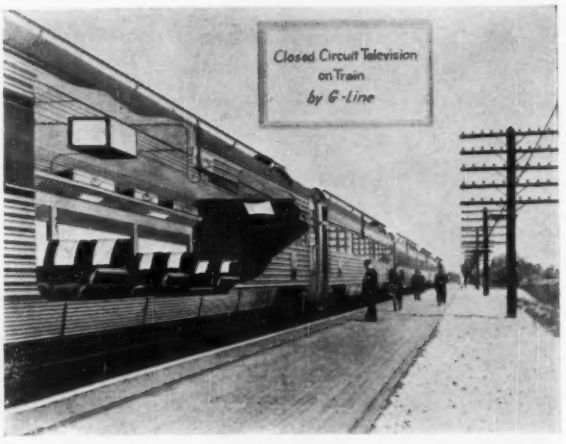

Fig. 9. Television on train by G-Line (photo-composition).

CONCLUSION

MICROWAVE ON POLE LINES replaces open wires, coaxial cables, waveguides and r-f links. It is a practical tool; its parameters are well defined and can be used as well as those of another cable. Completed systems are in full agreement with experiments and theory.[8]

Public utilities can exploit their extensive pole plant without FCC channel allocation. There is no limit to distance, and r-f equipment—terminal as well as intermediate—is available for connection. The New York Central G-Line proved the economy and operational characteristics of this system. Since long-distance communication systems can only be demonstrated if the system is actually installed and operated, our public utilities as pole owners and our wire manufacturers must co-operate with the system engineers if the G-Line is to be used to its full broad-band and low-loss capabilities.

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Two-Oscillator Scan Stability

H. M. JOSEPH
MEMBER AIEE

MANY are familiar with raster patterns, particularly the example seen on the face of television receivers. In order to present the most picture information with least bandwidth, such regular raster patterns are stabilized by synchronizing signals, derived by subdividing the frequency produced by a piezoelectric crystal stabilized oscillator. However, the simplicity of using an independent, stable oscillator for each of the vertical and horizontal deflection waves has been appealing. This was especially so for the extensive circuitry and subdivision needed to furnish the high-speed scans and quadruple interlace required when Avion-Alexandri carried out a U.S. Air Force RADC contract to pursue the experiments in electronic image processing done at the National Bureau of Standards.[1]

The results of trials with crystal-controlled oscillators were somewhat contradictory. Some rasters formed from apparently good frequency pairs were drastically reduced in number of lines by a slight thermal drift. Other very nearly equal pairs of frequencies controlled by similar crystals were quite stable. It was apparent that sufficient stability might be obtained with great simplicity; consequently, an analytical determination appeared to be desirable.

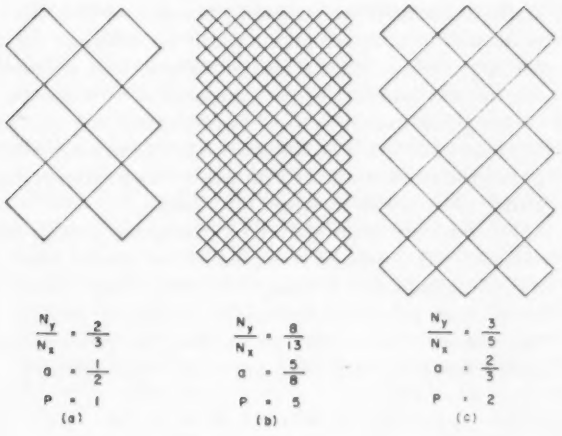

Fig. 1. Effect of change in scan ratio.

The number of raster lines depends upon the number of circuits or loops made by the deflected, writing electron beam during each frame period. This number is determined by the numerical relation between the vertical and horizontal frequencies; i.e., the raster scan is a complex Lissajous figure. The stability problem becomes that of determining the maximum relative frequency drift that maintains the complexity of the figure. The analytical problem is that of keeping the denominator of the proper fraction reduced to lowest terms left after dividing the larger deflection frequency by the other, at a high enough value.

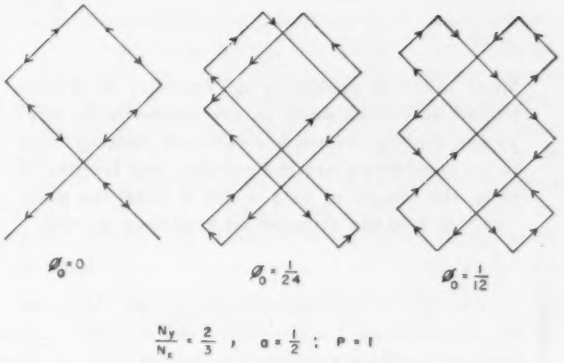

Fig. 2. Examples of effect of phase change.

The analysis is not as straight forward as it may appear since integer solutions to Diophantine equations are needed to determine the drift range that maintains the denominator at a high value. The effects of relatively small drift in the magnitude of the fraction are shown in Fig. 1 for a simple raster formed from symmetrical triangle waves. In addition, the relative phase of the waves produces the results illustrated in Fig. 2. It causes the number of lines to vary by a factor that is always less than 2.

In addition to finding the integer solutions, it is necessary to consider the practical viewing quantities of observation time and effective resolution. For ordinary values, the stability range required for nearly equal x and y deflection frequencies is quite readily provided. This is true when corrections for practical viewing conditions are made, but the specific frequencies must be chosen for a maximum drift range. The calculated Lissajous figure stability can be applied to any monotonic wave, such as a sawtooth or sine wave. In addition to the uses in image scanning, it appears that the results may be applied to the precision, oscillographic measurement of frequencies.

Digest of paper 59-1179, recommended by the AIEE Basic Sciences Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Fall General Meeting, Chicago, Ill., Oct. 11-16, 1959. Published in AIEE *Communication and Electronics*, Jan. 1960, pp. 1022-28.

H. M. Joseph is with the Johns Hopkins University, Silver Spring, Md.

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Trunking Facilities for a Primary Telephone Switching Point

B. A. CONNOLLY

Steps taken in providing toll facilities for a controlled switching point in the nation-wide telephone dialing system are outlined. Among items to be considered are the number and lengths of calls, the length of time a call is held, the point called, and the anticipated economic growth.

IT HAS BEEN considered economically desirable, at the present time, for the New York Telephone Company to establish a primary switching point at Binghamton, N.Y., with the toll traffic handled by means of a crossbar tandem office. Thus, it has become necessary to proceed with the design and the provision of adequate toll circuits and switching equipment to haul the message traffic to and from Area Code 607 (the Binghamton area). The normal steps taken in providing the toll facility portion of this job will be reviewed here.

BASIC DATA

BASICALLY, the design of all of the company's telephone plant is determined by the calls originated by subscribers, the length of time the call is held, the point called, and the anticipated economic growth, both from a local and a national standpoint. This traffic data is received from a number of sources, such as:

1. A point-to-point record made every 2 years for a period of 5 business days, Monday through Friday. This is usually done in the month of August, and a complete count of all toll messages is taken in the New York Telephone Company area. All toll tickets are reviewed during this period.
2. By means of registers, a record is kept of each toll group for a 5-day period in each month of the year. This not only permits the review of traffic requirements in order to determine the adequacy of the facilities existing at that time, but also indicates the busy month of the year and permits the determination of a factor which can be applied to the point-to-point record taken in August.
3. An estimate of station growth is secured from the Commercial Department. This indicates the probable increased originating traffic.
4. The staff furnishes an estimated per-cent toll message growth, based on the present economic view.
5. A study is made directly following the point-to-point count to determine holding times. These are determined from a sampling of calls of varying charges to which is added work time, i.e., the period of establishing the connection.

With the aforementioned basic data, we are now in a position to proceed with our engineering, and the initial step in this is the routing of calls to particular circuit groups, that is, groups between two toll offices. Large volumes of traffic between toll offices are generally routed economically over direct intertoll trunks. When the volume of traffic is small, however, the use of direct trunks is usually not economical. In these cases the traffic is then handled by connecting together, by means of switching equipment at intermediate toll offices, two or more intertoll trunks to "build up" the required circuit. The places where the interconnections are made are generally known as intertoll switching points and the process is referred to as a "switch." Built-up connections may involve several intertoll switching points, in order of their rank, if the originating and terminating points are a great distance apart and the traffic volume involved is small. Although this multiswitched traffic constitutes only a small portion of the total, it is important that telephone plant be designed to care for it as well as for the greater volume that is handled via the less complex direct and single-switch routes.

Our point-to-point record has indicated the type traffic to be handled. The first step is to route manually on paper the traffic indicated on this point-to-point record, either to direct or to switching groups.

For instance, there may be a Chenango Bridge–Schenectady, N.Y., item of traffic which we would route on the Binghamton–Chenango Bridge, Binghamton–Albany, and Albany–Schenectady switching groups. In like manner, all traffic shown on this point-to-point record would be routed to particular traffic groups.

SUMMARIZATION

WE TAKE ADVANTAGE then of a mechanized process of summarization, accumulating all of these traffic items by traffic groups. To this, still by means of the mechanized process, the following factors are applied:

1. A percentage which will reflect the traffic in the busy period of the year as compared with that in August, the date of the point-to-point record.
2. The percentage busy hour. It must be understood that the messages we have at this point are for a 24-hour day. This factor would be a percentage of the busy-hour traffic to the complete day's traffic.

A special article recommended for publication by the AIEE Communication Switching Systems Committee.

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3. The holding time. This is the average number of seconds for the call.

4. Growth factors which reflect the growth in messages from the time of the point-to-point study and into the future for a period of 2 or 3 years.

These last factors are multiplied in the process to produce one factor. The messages are totaled by traffic group for each year, the factor applied, and the resulting figure is the CCS load for each traffic group. (One CCS is the equivalent of 1 call for 100 seconds, or 3 calls for 33.3 seconds each, etc.) These CCS's can now be used with engineering schedules based on the theory of probability to determine the number of circuits required.

It should be mentioned here that these schedules are generally called *PO1, PO2,* and *PO3,* etc., and they indicate the probability of a subscriber's finding a trunk busy during the particular busy hour. For instance, *PO1* indicates the probability of 1 in 100 calls finding a busy condition; *PO2,* the probability of 2 in 100 calls, etc. Using these schedules should provide sufficient trunks in the most economical manner to give excellent service. For instance, longer circuits, such as the circuit from the primary center to the sectional, are on a *PO3* basis, the toll center to primary center on a *PO3,* and the end offices generally on a *PO1.* In this way the end links, the most inexpensive portion of the trunk, are provided on a more liberal basis in order not to cause a bottleneck on a long distance call.

DETERMINING TRUNKS DESIRED

Prior to operator or subscriber dialing, we would at this point have determined the trunks required. With direct distance dialing (DDD), our centralized automated message accounting system (CAMA), and alternate routing, the process is somewhat more difficult.

As an illustration, take the simple case of Chenango Bridge, which is an end office of Binghamton. Here, we may assume, the traffic has been routed as outlined previously and we find from our summary that the Binghamton–Chenango Bridge group would need to carry 156 CCS's as the busy-hour load. However, examination of the originating traffic in our point-to-point data indicates the calls that can be customer-dialed. This eliminates the collect, person-to-person, and originating coin messages which, pending further development, are not generally customer-dialable traffic today. It is determined that 65% of the calls the customer may dial himself. Now, if we assume that one half of the 156 2-way CCS's are for originating traffic, we apply this CAMA percentage to the originating figure, i.e., 65% of 78. This is the amount of dialable traffic and it will require 5 circuits. The remaining 104 CCS's are for non-customer-dialed and incoming calls to Chenango Bridge. This traffic would require 8 non-DDD trunks. In other words, we now know that 13 circuits are required for all traffic in this group. In this case, Chenango Bridge is an Independent Company owned office and we work together with this Independent Company in accumulating the traffic data and estimating the circuit requirements.

HIGH-USAGE DIRECT GROUPS

One other point of some moment is the estimating of high-usage direct groups. As previously mentioned, a detailed summary of traffic items by traffic groups has been made by the mechanized process. A review of these details is made and where it is found economical, from a cost standpoint, to handle portions of this traffic over a direct high-usage group, this group is established.

As an example, the traffic from Binghamton to Syracuse may be cited. Normally, this traffic would route from Binghamton to Albany and thence to Syracuse; that is, from a primary center to a sectional center and back to a primary center. This normal routing would result in the use of about 350 miles of facilities and three switches. By establishing a direct Binghamton–Syracuse route, a large share of this traffic is handled over 70 miles of facilities using only two switches. The remainder or spillover will overflow over the 350-mile final route.

For control of these trunks at Binghamton, trunk-usage recorders have been installed. With these, trunk groups are electronically scanned repeatedly at 100-second intervals, and the circuits found busy in each group are scored on registers. At the end of 36 scans, or a period of 1 hour, the cumulated "busy's" indicate the load that was carried, in 100-second calls (CCS units). This type of information will allow plotting a curve which keeps us continually aware of the status of the traffic. It is hoped, too, that in the future it might be the basis for complete mechanization of our traffic estimating.

Our ultimate purpose is the provision of the facilities and establishment of circuits for this requirement. Again we resort to the mechanized method of summarization. The traffic circuits having been determined are now routed physically over toll routes as differentiated from the traffic routes mentioned previously. These are our established cables, radios, or carrier routes.

These routes are divided into sections where, because of a difference in available facilities or in requirements, they vary from each other. Each of the circuit groups is routed and the cards punched to indicate the physical routing. To this are added the circuit requirements previously determined. By this simple method, the requirements for the present and future 2-year period may be summarized by cable or carrier section. Inasmuch as our available facilities in each cross-section were predetermined, we have but to compare the "required" with the "availables" to determine our shortages and where relief is indicated.

The relief to be provided, whether it be cable or carrier, is determined on an economic basis. Engineering economy studies are made, where necessary, but in most cases previous studies have indicated the type of relief to provide. There are also rule-of-thumb methods for checking the reasonableness of the relief. For instance, *N* carrier generally proves in on cable routes for distances beyond 20 miles, *ON* carrier for distances of 50 miles or more, *R* carrier (microwave) while it was 100

miles is now shortened considerably and must be watched, *K* and *L* carrier for distances of 100 miles. These carriers are 12-channel carrier systems, with the exception of *ON* which is a 20-to-24-channel type. For the few open-wire routes that we now have remaining, a 4-channel type carrier system is used for distances exceeding 16 miles in length. This resulted in the addition, by the New York Telephone Company, of the following carrier facilities for Binghamton:

10 20-channel *ON* carrier systems
25 12-channel *N* carrier systems
6 12-channel *R* carrier (microwave) systems
2 4-channel *O* carrier (open-wire) systems

The Long Lines Department on their part provided 6 20-channel *ON* systems and 10 12-channel *R* systems for the interstate traffic.

ESTABLISHMENT OF CIRCUITS

THE FINAL STEP on completion of the construction is the establishment of the circuits for which these new facilities were provided. A trunk layout engineer assigns the pairs or carrier channels, the associated repeaters, and signaling and terminating equipment, calculating the transmission, levels, gains, etc. to permit this circuit to function satisfactorily. Detailed instructions are sent to the field forces to establish the circuits.

In the establishment of trunk facilities, it is of paramount importance that these facilities provide good communication. This is the transmission aspect, the speech volume, the fidelity, and the freedom from disturbance. Here again the toll-switching pattern is designed to meet our "via net loss" objective. (Via net loss is defined as a condition of an intertoll trunk which establishes the minimum loss consistent with satisfactory echo, noise, and singing conditions.) The limits will provide a maximum of 18 db for any call within the United States. Of course, it must be appreciated that all circuits are designed to operate at as low equivalent as is possible, and it is ultimately planned to provide facilities that would compare with a conversation carried on between two people about 3 to 6 feet apart.

In determining the db loss, the attenuation loss, singing, echo, noise, and crosstalk must be taken into consideration. Normally, one would feel that the attenuation loss that resulted from the impedance and length of facilities could be eliminated by gain devices to provide a "zero-db" circuit and this could be done were it not for singing of the gain devices (amplifiers), echo, noise, and crosstalk.

The echo is the reflection back of the speaker's own voice because of impedance mismatches at each of the gain devices.

Singing will occur in the gain devices if the sum of the gains exceeds the sum of the losses for any frequency. This is most pronounced in the frequency ranges of 250 to 500 and 2,500 to 3,000 cycles. One of the interesting aspects of singing is that a singing impairment occurs previous to the actual singing in the form of a "hollow effect" such as that of shouting into a rain barrel.

Noise and crosstalk are items that are best controlled by the layout design and construction of the plant. In carrier systems, this is controlled by the location of repeaters and terminals and by suppression devices, and in voice-frequency cable systems by balancing conductors and using sound-splicing practices. In open-wire systems, transposing of wires accomplishes this end.

Of the aforementioned problems, the controlling one usually is the echo. To determine the lowest loss at which a built-up connection can be operated satisfactorily from an echo standpoint, it is only necessary to multiply the via net loss factor (each type facility has a different factor) by its length and add 0.4 db (an allowance per link for variations from the assigned values).

As an example, for a 10-mile *H88* cable section, a 0.8-db intermediate link is designed as follows:

Actual attenuation loss

10 miles $\times$ 0.42 db per mile + (2 $\times$ 0.5 coil losses) = 5.2 db

Via net loss

10 miles $\times$ 0.04 db per mile + 0.4 db = 0.8 db

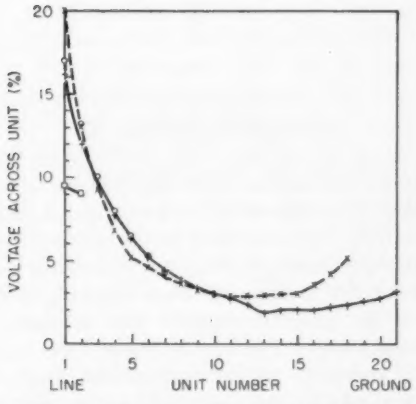
Required repeater gain = 4.4 db

Global Communications Network

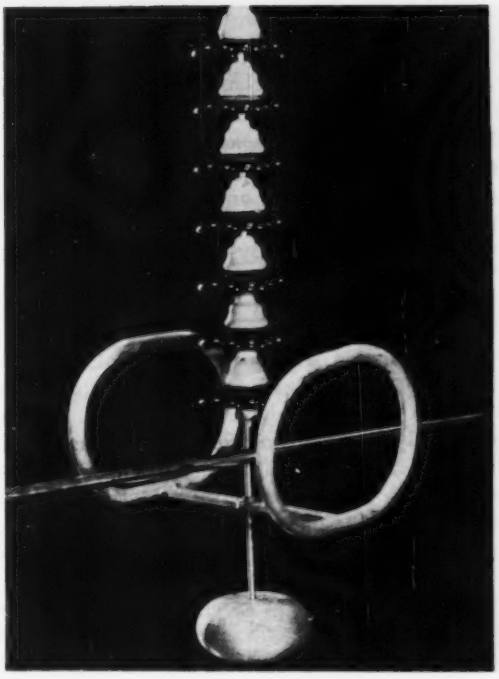
The U. S. Air Force recently inaugurated at Siegelbach, Germany, a 450-000-mile vital defense communications network. This global system, specially engineered by Western Union Telegraph Company for the Air Force, consists of 10 automatic high-speed message centers. Shown here is a scene in one of the "switching aisles" in a typical center from which messages move at 100 words per minute between Air Force stations.

Electric Stress Grading of Insulator Strings

A. S. DENHOLM
ASSOCIATE MEMBER AIEE



▲ **Fig. 1. Voltage per unit without grading rings. +—present results, 21-unit string: conductor 4 inches below bottom skirt; x—18-unit string; o—21-unit string, by extrapolation; □—optimum improvement with rings.**



► **Fig. 2. Arrangement for determining the effect of grading ring position on voltage distribution.**

THE component units of an insulator string do not carry equal voltages when the string is in service, because of stray capacitances from each unit of the string to line and to ground. The voltage across a particular unit in a string may be determined by placing a calibrated spark gap across that unit and noting the total string voltage required to make the gap spark. Obviously, the presence of the gap should not change the potential distribution of the string by introducing capacitance or ionization. Fig. 1 shows the potential distribution curves for strings of 18 and 21 units, and it can be seen that the line end units are the most highly stressed. The voltage across these units can be reduced by fitting grading rings at the line end of the string, which increase the capacitance of these units to the line. Several shapes of grading ring have been used, but probably the most common is that shown in Fig. 2. Experiments have demonstrated that with this form of ring, the best position is as high, relative to the string, and as close to it as is practicable. This fact is also of appreciable significance in the design and positioning of grading rings of various other shapes.

The extent to which the distribution of potential of an insulator string is nonuniform strongly affects the flashover voltage of the string and its radio interference properties. Whether or not a specific insulator generates interference when present in a string at a particular string voltage depends on the radio influence voltage/voltage characteristic of the unit when tested alone and its position in the string. As might be expected from the data of Fig. 1, experiments show that the line end unit is the most important one. Unless its immediate neighbors are a great deal noisier than it is, the line end unit dictates the radio influence voltage quality of the string. If all the components of an insulator string have the same influence voltage characteristics, then the string develops essentially the same influence voltage as a string having one of these components at the line end and all the other units "ideal"; i.e., producing no interference within their service voltage.

The information obtained on the stress grading of insulator strings suggests that the use of bundle conductors rather than single conductors should improve the performance of suspension insulator strings by increasing the unit to line capacitance, particularly if the bundle is placed as high as possible relative to the string.

Digest of paper 60-90, "The Electric Stress Grading of Insulator Strings and their Radio Influence Voltages," recommended by the AIEE Transmission and Distribution Committee and approved by the AIEE Technical Operations Department for presentations at the AIEE Winter General Meeting, New York, N. Y., Jan. 31–Feb. 5, 1960. Published in AIEE *Power Apparatus and Systems*, June 1960, pp. 167-74.

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A Digital Computer Simulation of Single-Track Railroad Operation

R. T. COUPAL L. L. GARVER W. R. SMITH

The digital computer signal program described aids railroad management in the selection of proper siding locations and signal spacing and permits the evaluation of the effects of possible changes in right-of-way signal equipment or train schedules.

IMPROVED signal systems such as centralized traffic control (CTC) have enabled railroads to move train traffic on a single main track with passing sidings that formerly required two tracks or the general use of train orders and timetable authority. A digital computer program has been designed to aid railroad management in selecting the proper siding locations and signal spacing when considering a CTC system. By use of an IBM *650* computer, the traffic pattern of up to 10 trains operating at one time on a 100- to 150-mile division of a railroad may be predicted. The initial information stored in the computer memory describes the grades, curves, speed restrictions, signal locations, and track layout of the railroad. Also, data for each train is available to the computer. This information includes the number, weight, and type of cars, the power of the locomotive, the origin and destination, and the time of departure.

The program to be described in this article directs the computer to determine the time of arrival and departure of each train at each siding or station along the railroad, taking into account the conflicting route requirements. It is also the function of the computer to provide the location of train meets or passes.

As one train reaches its destination, the data for another train may be read into the computer. Thus, many trains, representing days of railroad operation, may be studied. Data describing the trains or track layout may be changed easily. This allows the study of railroad operation under the conditions of varying train departure times on a given railroad, or fixed departure times and varying siding locations and signal spacings.

Full text of paper 60-47, presented at the AIEE Winter General Meeting, New York, N. Y., Jan. 31–Feb. 5, 1960. Recommended for publication by the AIEE Land Transportation Committee. Scheduled for publication in AIEE *Applications and Industry*, Sept. 1960.

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The authors wish to acknowledge the assistance in obtaining actual railroad drawings and train graphs given by personnel of the signal department of the Canadian Pacific Railroad, who also have given counsel on actual railroad operating practices and possible means of simulation.

THE DIGITAL COMPUTER

FOR THOSE not familiar with the elements of an IBM *650* computer, the following brief description will aid in understanding the terms used in this article. The electronic digital computer may be visualized as three functional units: a magnetic drum memory, arithmetic unit, and the program register. The magnetic drum memory has a capacity of storing 20,000 digits (numbers *0* to *9*) in groups of 10. Each group with a sign is considered a word, making a total of 2,000 words. A word is located on the drum by a 4-digit address. The arithmetic unit performs multiplication, division, addition, and subtraction. This unit can locate and use information stored on the memory drum without destroying the information. Further, it is capable of placing the results of its computations in the memory. The program register controls the sequence of operations performed by the arithmetic unit. The program register can recognize when the result of any operation is zero or nonzero, plus or minus, and can also examine any digit of a word for an *8* or *9*. With these features, logic may be programmed into the computer. The transferring of information from punched cards into the memory and the punching of information from the memory onto blank cards are also controlled by the program register. The sequence of instructions interpreted by the program register is called the program.

THE PROGRAM

THE PROGRAM necessary to simulate the operation of many trains running on a single track is separated into two parts. The calculation program provides the instructions and data necessary to predict the speed–time–distance characteristics of any train mathematically. With this information, the computer may calculate how much time will elapse as a train travels from one portion of the railroad to another. The route logic program provides the computer with a numerical method of visualizing the track layout of a railroad and the positions of the trains. The computer must have available the necessary data and instructions so that when two trains conflict, one train may be recalculated into an available siding.

The Calculation Program. The calculation program provides the speed–time–distance characteristic for each train to be moved over the railroad. This is accom-

plished by solving the force equation for train acceleration

$$\text{Acceleration} = \frac{\text{Locomotive Tractive Effort} - \text{Train Resistance}}{\text{Mass of the Train}}$$

For diesel–electric operation, which has been assumed in this development, the tractive effort is related by a constant to the locomotive horsepower divided by train speed. The train resistance is a function of train speed, car weights, and other factors. For this program the Davis formula and constants are used.[1] The appendix contains a development of the actual formula used. The train resistance is related to the types of cars and their weights, the speed of the train, and the grade and curvature of the track. Therefore, data for both the train and the track characteristics are stored in the computer memory. The storage of the train data will be covered later in this article. The track data contains one entry for each change in grade or curvature, and there are approximately four of these changes per mile to be expected on an average railroad. The data on these track sections are stored sequentially in the computer memory with one location necessary for each section of constant grade and curve.

In the 10-digit track data number, three digits represent the acceleration per ton due to the grade in this section, two digits represent the acceleration per ton due to curvature (always negative), and three digits give the length of the section in tens of feet. The remaining two digits give a speed limit in miles per hour that may be imposed by the railroad timetable because of such things as a sharp curve, tracks through a city, or a crossing with another railroad.

Using the foregoing train and track data, the computer calculates the progress of the train along the railroad. The acceleration available is computed and if a change in velocity is indicated, it is solved by the following equations:

$$V_2 = V_1 + at$$

$$X = \frac{V_1 + V_2}{2} t$$

where

a = acceleration available at speed V_1
V_1 = initial speed
t = 6-second constant acceleration period
V_2 = speed after the acceleration
X = distance traveled

No change in velocity is indicated either by zero acceleration available or when the speed is greater than a speed limit but not greater than the speed limit plus 5 mph. The time to travel the next distance is then calculated by dividing the distance by the speed. Thus, the time to travel from one portion of the railroad to another may be calculated for any train.

The Route Logic Program. The route logic program directs the computer in determining points of train conflicts and sidings where the trains may pass. The signal system on an actual railroad divides the track into sections called signal blocks, which may be occupied by only one train. Therefore, these signal blocks, actual or proposed, were chosen to be the sections used by the computer to visualize the railroad. Each signal block was assigned one memory location for its data and the sequence of signal blocks determined the sequence of memory locations.

Of the ten digits in each memory location representing a signal block, four digits represent the length of the section in tens of feet, four digits indicate the presence of a train in the block, and the remaining two digits indicate the type of signal section. The types of signal sections considered in this program and their code numbers are given in Table I.

Table I. Types of Signal Section Considered

Code Number	Name	Represents
00	Intermediate	Single mainline track with no entrance to sidings
02	Double Track Intermediate	Double mainline tracks with no entrances to siding
10	Approach	Single mainline track with a switch to a siding at one end
20	Mainline	Single mainline track adjacent to a siding
30	Siding	Single track siding
50	Transition	Double mainline tracks at the transition from a single mainline track

Certain operations have to be performed as the train is calculated from one signal block to another. Many of the operations are unique to the two types of blocks involved. In order to locate the program for these operations, the computer is directed to take the first digit of the type code of the block occupied and add the 2-digit type code for the block ahead of the train. This forms a 2-digit number unique for the two signal blocks involved and the direction of travel. This number is added to a master 4-digit number to form the address of the first instruction in a subroutine. For example, when the computer calculates that a train is preparing to enter an "approach" block from an "intermediate" block, the numbers *0* and *10* are added to form *10* and then combined with the master number *1300* to give *1310*. This is the address of the first instruction in the subroutine.

As mentioned previously, four digits in the signal block data are used to indicate the presence of a train in that block. This 4-digit number, termed a train marker, is the address of the first word of data for the train. The digits are zeros when no train is in the block. The data address of a train in the signal data forms one half of a cross reference, so that when given a train marker the entire data for the train may be located. The other half of the cross reference is formed by storing with the train data the address of the signal section occupied. Therefore, given the train data, the signal data for the section occupied and those around it may be located.

To simulate the movement of the train along the railroad, the train markers are moved from signal block

to signal block. The computer calculates the time at which a train will enter the next signal block and stores it with the train data. When this time is earlier than the times stored with the other trains, the train marker is placed into the signal block ahead. The computer then calculates the time when the last car of the train will clear the block behind. Time, speed, and grade section location are stored back with the train data. When the other trains have been moved in a similar manner and the time for this particular train is again the earliest, its train marker in the block behind is replaced by zeros. Fig. 1 sketches the path of a train

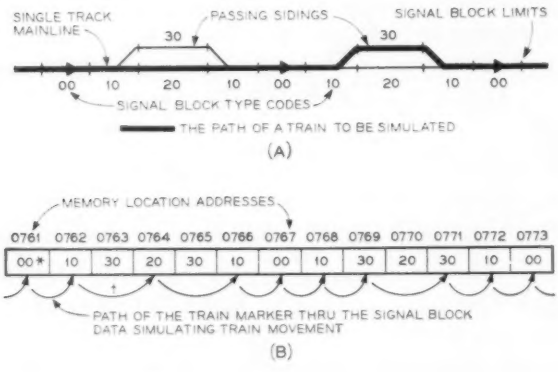
SINGLE TRACK MAINLINE
PASSING SIDINGS
SIGNAL BLOCK LIMITS
30
30
00 10 20 10 00 10 20 10 00
SIGNAL BLOCK TYPE CODES
THE PATH OF A TRAIN TO BE SIMULATED
(A)
MEMORY LOCATION ADDRESSES
0761 0762 0763 0764 0765 0766 0767 0768 0769 0770 0771 0772 0773
00* 10 30 20 30 10 00 10 30 20 30 10 00
†
PATH OF THE TRAIN MARKER THRU THE SIGNAL BLOCK DATA SIMULATING TRAIN MOVEMENT
(B)

Fig. 1. Methods used to simulate train movement: (A) Railroad track and signal diagram; (B) Computer memory drum representation.

*Only the first two of 10 digits are shown in each memory location. †Sections not used by the train are skipped by the memory. Two *30* sections are used to allow two trains to use the same siding when direction and length permit.

marker in representing a train movement. The sequence of this cycle is repeated as follows:

1. Enter the train marker in the block and calculate the time when the block behind will be cleared.
2. Move the other trains as required.
3. Zero the block behind and calculate the time to enter the next signal block.
4. Move the other trains and return to 1.

A conflict occurs when two trains try to occupy the same signal block. Railway signals, however, will also detect the presence of a train in the second block ahead and on a following move will indicate a 30-mph speed limit for a train entering the section. This also will constitute a train conflict, especially when a fast passenger train overtakes a slow freight train. Therefore, the route logic program directs the computer to test both the first and second signal blocks ahead of a train for occupancy. If no train is found, the program continues as described in the previous paragraph. The largest portion of the route logic program is devoted to instructions directing the computations when a train marker is located. The pattern of these instructions becomes very involved, but the general form may be understood by referring to Fig. 2.

The important information for this program was contained in numbers, called markers, that could be zero or nonzero, *8* or *9*, and positive or negative. The train marker used in the signal block data is one example of a zero or nonzero marker. The program register of the computer is able to recognize these three types of qualities and then branch to its next instruction accordingly. Some of the uses of these three types of markers are as follows:

1. The sign, positive or negative, of the first word of train data is used to mark the train direction.
2. Another word in the train data group, when nonzero, marks that the train has conflicted with another train.
3. The number *8* in a specific digit of the train data marks the train as being a freight train. The number *9* marks a passenger train.

Other important information conveyed by markers includes the answers to the following questions: Was this train in the last siding passed? Is this train being rerun after conflicting with another train? Is the train in an "approach" signal block and preparing to take the siding? These markers with two allowable states direct the computer to follow the particular instructions necessary for any train conflict and rerunning involved.

SCHEDULED DELAYS

THE PROGRAM just described has assumed that all trains would be operated to travel the railroad in a minimum amount of time as allowed by locomotive power and route conflicts. In actual practice, however, many trains are required to stop somewhere along the railroad. A local freight train will make many stops to set off and pick up cars. A passenger train makes scheduled stops and at other points has scheduled passing times. A subprogram is included to allow the simulation of three types of delays: a stop for a definite period of time; a stop for a definite period of time but the train may not depart until a scheduled time has passed; and a scheduled entry time where the train need not stop but it cannot enter the next block until the scheduled time has passed. This program requires the use of a memory location for each train and the data must be stored in the computer memory before the calculation begins.

TRAIN DATA

THE TRAIN DATA includes information for use in both the calculation program and route logic program. Ten groups of 20 words each have been reserved in the memory for train data. This allows 10 trains to operate on the simulated railroad at one time. Additional train data may be read from cards into an area made available when a train completes its run, thus allowing days of operation to be studied without continually stopping the computer. Table II is a list of the information contained in the train data area and the number of digits required.

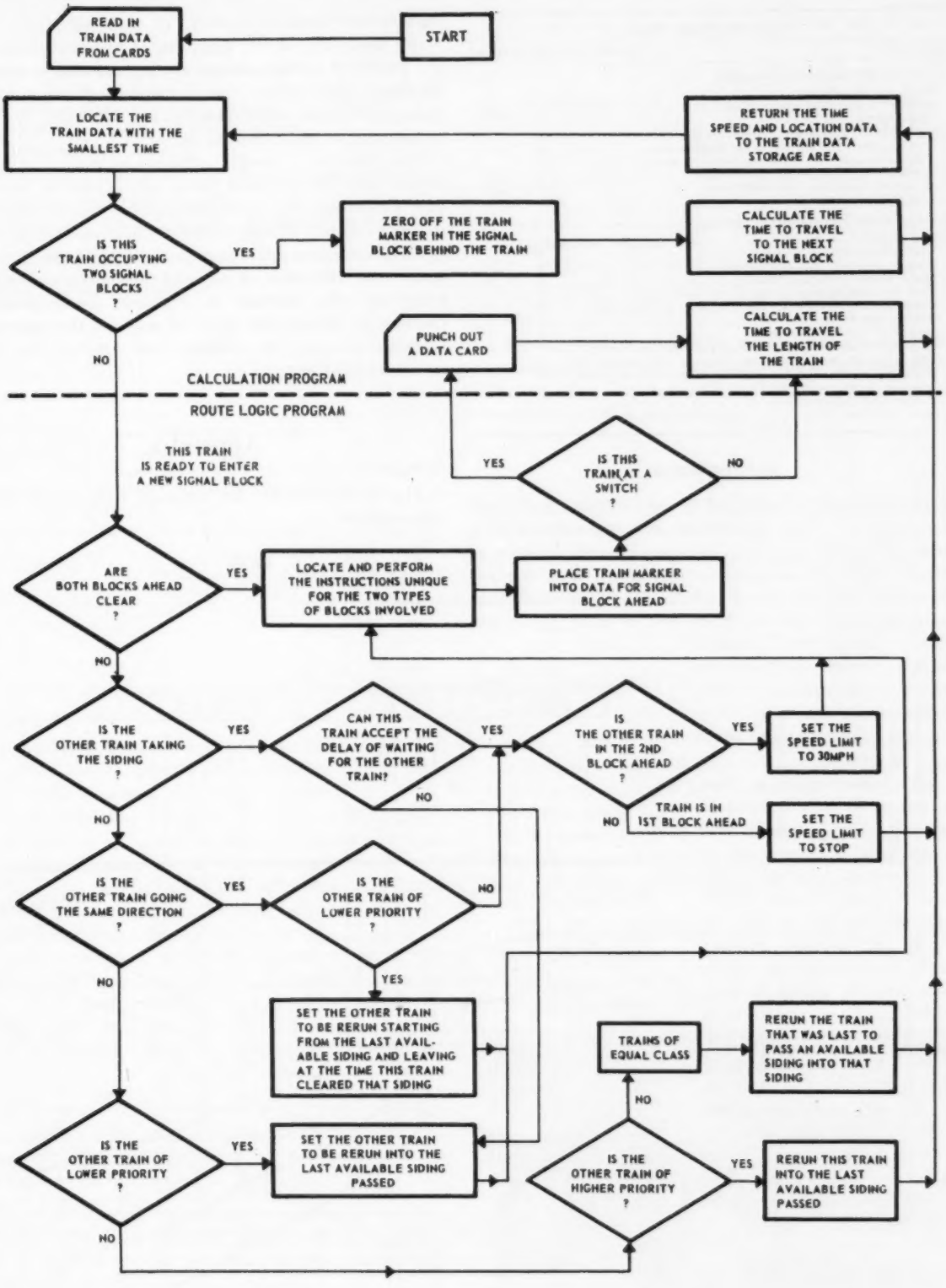
START
READ IN TRAIN DATA FROM CARDS
LOCATE THE TRAIN DATA WITH THE SMALLEST TIME
RETURN THE TIME SPEED AND LOCATION DATA TO THE TRAIN DATA STORAGE AREA
IS THIS TRAIN OCCUPYING TWO SIGNAL BLOCKS ?
YES
ZERO OFF THE TRAIN MARKER IN THE SIGNAL BLOCK BEHIND THE TRAIN
CALCULATE THE TIME TO TRAVEL TO THE NEXT SIGNAL BLOCK
NO
PUNCH OUT A DATA CARD
CALCULATE THE TIME TO TRAVEL THE LENGTH OF THE TRAIN
CALCULATION PROGRAM
ROUTE LOGIC PROGRAM
THIS TRAIN IS READY TO ENTER A NEW SIGNAL BLOCK
YES
IS THIS TRAIN AT A SWITCH ?
NO
ARE BOTH BLOCKS AHEAD CLEAR ?
YES
LOCATE AND PERFORM THE INSTRUCTIONS UNIQUE FOR THE TWO TYPES OF BLOCKS INVOLVED
PLACE TRAIN MARKER INTO DATA FOR SIGNAL BLOCK AHEAD
NO
IS THE OTHER TRAIN TAKING THE SIDING ?
YES
CAN THIS TRAIN ACCEPT THE DELAY OF WAITING FOR THE OTHER TRAIN?
YES
IS THE OTHER TRAIN IN THE 2ND BLOCK AHEAD ?
YES
SET THE SPEED LIMIT TO 30MPH
NO
NO
TRAIN IS IN 1ST BLOCK AHEAD
SET THE SPEED LIMIT TO STOP
NO
IS THE OTHER TRAIN GOING THE SAME DIRECTION ?
YES
IS THE OTHER TRAIN OF LOWER PRIORITY ?
NO
YES
NO
SET THE OTHER TRAIN TO BE RERUN STARTING FROM THE LAST AVAILABLE SIDING AND LEAVING AT THE TIME THIS TRAIN CLEARED THAT SIDING
TRAINS OF EQUAL CLASS
RERUN THE TRAIN THAT WAS LAST TO PASS AN AVAILABLE SIDING INTO THAT SIDING
NO
IS THE OTHER TRAIN OF LOWER PRIORITY ?
YES
SET THE OTHER TRAIN TO BE RERUN INTO THE LAST AVAILABLE SIDING PASSED
IS THE OTHER TRAIN OF HIGHER PRIORITY ?
YES
RERUN THIS TRAIN INTO THE LAST AVAILABLE SIDING PASSED
NO

Fig. 2. Flow diagram of computer program for predicting railroad operation.

Table II. Train Data

Information	Number of Digits Required
For Use in the Calculation Program:	
Grade section address	4
Distance to the next grade change	4
Train speed	3
Speed limits (maximum and present)	4
Braking rate with normal brake application	4
Three constants for train resistance formula	10
Constant for locomotive tractive effort	6
Minimum speed for full horsepower	3
Next delay location	8
For Use in the Route Logic Program:	
The direction of travel	sign
Train identification number	3
Priority number and type	2
Train Marker for this train	4
Time for next change in signal block occupancy	4
Signal block address that Train Marker is occupying	8
Conflict marker	10
Length of the train in feet	4
The address and time of clearing past the last siding	8
The grade section and distance to go at the last siding	8
The same information for the 2nd to last siding passed	16
Train being rerun marker	1
In approach taking siding	1
Been in siding	1

ANSWER CARDS

ANSWER CARDS are punched by the computer each time it calculates a train passed the entrance or exit to a siding. These cards contain the train identification number as originally assigned in the input data, the addresses of the two signal blocks the train marker is occupying, the time the front end of train passes the switch, and the conflict marker, which is normally zero but will contain a train marker when the train is being rerun into a siding for a meet or pass.

The information on these answer cards may be plotted to give the time–distance graph, called a train graph, of the simulated railroad operation. It is these train graphs, such as shown in Fig. 3, which aid railroad management in choosing the siding locations best suited to their traffic needs or which show the effect of rescheduling trains on an existing track layout. The heavy lines on the train graph show the traffic pattern predicted and the dashed lines are calculations that were made but were superseded by a rerun as the result of train conflicts.

CONCLUSIONS

THIS PROGRAM is offered as an aid to railroad management for evaluating the effects of possible changes in right-of-way signal equipment or train schedules. The major advantage of the computer is its ability to locate the points of conflict before having to make a routing decision. This allows the horsepower-per-ton, grade, curve, and speed restrictions to have full effect in determining where meets will be made.

New data for a complete change in track and signal layout may be prepared from blueprints in one-half day. Train data such as departing time may be changed in a few minutes. Using the IBM *650* computer, approximately 8 minutes are required to calculate one of many trains over 100 miles of railroad. The program offers a relatively easy method to evaluate many proposed changes in either the right of way or the operating schedule without the expense and difficulty involved in actual field tests.

Appendix

The Davis formula for railroad freight car rolling resistance is:

$$R = 1.3 + \frac{29}{W} + kV + \frac{CAV^2}{Wn}$$

where

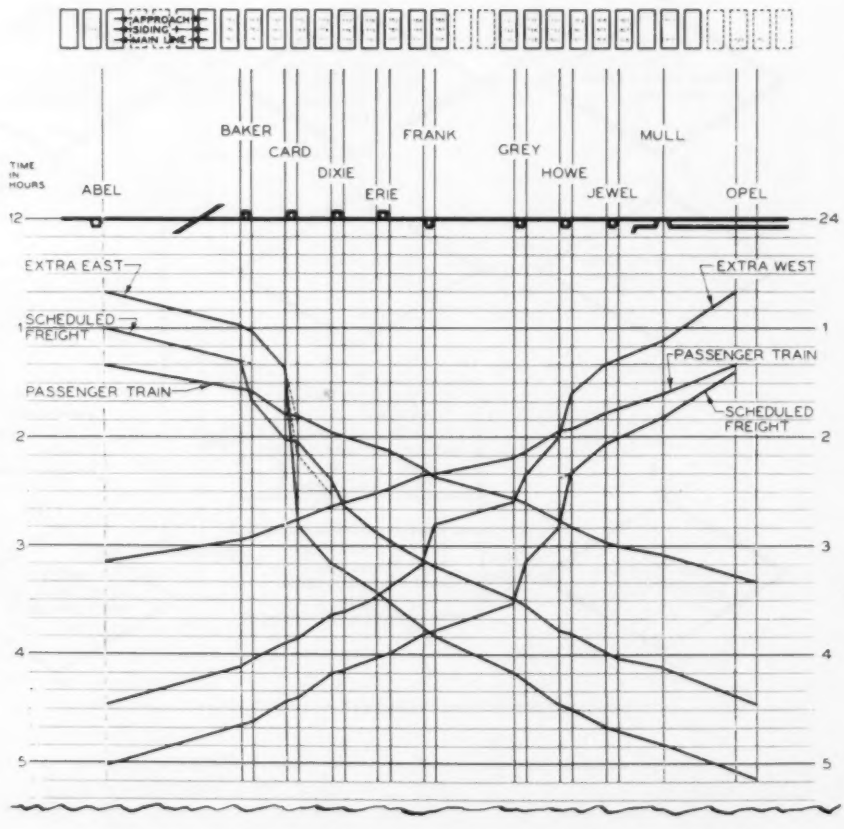

Fig. 3. Train graph predicted for the Trenton Division, Canadian Pacific Railroad.

R = resistance, pounds per ton
W = average weight per axle, tons
k = constant, depending upon equipment
V = speed, miles per hour
C = constant, depending upon equipment
A = effective cross-sectional area, square feet
n = total number of axles

The actual values for the constants mentioned may be found in reference 1, p. 85.

Combining this equation in the force equation

$$F = 100\ Wa + RW + 20\ PW + 0.8\ DW$$

and solving for acceleration,

$$a = \frac{F}{100\ W} - \frac{R}{100} - 0.2P - 0.08D$$

where

a = acceleration, miles per hour per second
F = force of the locomotive, pounds
$100\ W$ = effective mass, including inertia effect of rotating wheels
R = train resistance as given by the Davis formula
P = per-cent grade of the track
D = degrees curvature of the track

The force of the locomotive may be solved for by the equation

$$F = \frac{375\ (\mathrm{HP})\ 0.8}{V^*}$$

where

F = force of the locomotive available for overcoming train resistance, pounds
HP = rated horsepower of the locomotive
V^* = train speed or minimum speed for the maximum horsepower, whichever is larger

The minimum speed for maximum horsepower is considered to be the speed at which the locomotive tractive effort is equal to 25% of the weight of the locomotive on its driving axles.

REFERENCE

1. Train Resistance of Freight Trains under Various Conditions of Loading and Speed. *Proceedings*, American Railway Engineering Association, Chicago, Ill., vol. 42, 1941, pp. 69-86.

All-Transistorized Computer

Texas Instruments, Inc. (TI) recently accepted the first all-transistorized data-processing system delivered to private industry—an IBM *7070*.

P. E. Haggerty, president of TI, said his company looks forward with great anticipation to the new dimension this system adds to its management capability. Under TI's product-customer centering management philosophy, the manager of each of the company's 40 separate product centers requires prompt, accurate, and frequent processing of all information pertinent to the operation in order to discharge his basic responsibility for casting and manufacturing products which meet present and future needs of the customer.

Here are some significant facts and data on the IBM *7070:*

The completely transistorized *7070* incorporates the three basic types of data processing—punched cards, magnetic tape, and random access magnetic disks. Key features of the system are:

1. *High internal-processing speeds*—16,600 5-digit numbers can be added and subtracted in a second; in the same time span it can perform 860 multiplications of 10-digit numbers or 320 divisions.

2. *High tape-processing speeds*—It can read magnetic tape at the rate of 15,000 to 62,500 characters per second.

3. *Magnetic core storage*—50,000 to 99,990 digits can be stored for use as instructions or tables in processing data. Access time is 6 millionths of a second.

4. *Disk storage*—From 6 to 48 million digits can be stored on large magnetic disks. Access time to any record is a maximum of 850 milliseconds and a minimum of 105 milliseconds.

5. *Automatic priority processing*—Input and output units automatically signal when they are available for data, permitting maximum use of computing time.

Photo shows IBM engineers making final performance checks on the system prior to its formal acceptance by Texas Instruments, Inc.

Reduced Transformer Insulation Levels

J. R. MEADOR
FELLOW AIEE

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FURTHER BIL reductions will result as more is learned of switching surges and as lightning arrester protective levels are improved. For system voltages of 230 kv and above, it appears likely that the ultimate reduction in BIL will be in the order of 50% of the fully insulated value. This reduction is equivalent to "4-steps-down" although this nomenclature is not very precise and is used only in the absence of a better one.

With 50% BIL reduction, the transformer low-frequency test is in the range of 1.5 to 1.7 times maximum line-to-ground voltage, which appears to be a reasonable minimum ratio.

On the assumption that the switching surge strength of transformer insulation is 83% of the BIL, 50% BIL reduction requires that switching surges be held to approximately twice maximum line-to-ground voltage. To meet this value on a system using a 75% arrester, the switching surge spark potential must be limited to only slightly more than 1.5 times the arrester rating. This is not practical so long as industry rules require that the 60-cycle spark potential be not less than 1.5 times the arrester rating. The authors suggest that this rule be reviewed since its present purpose is obscure.

Improvements in apparatus have decreased the likelihood of high switching surge voltages. Present-day circuit breakers are much more restrike-free than earlier designs. Also, breaking transformer magnetizing current will produce much lower switching surge voltages where transformer cores have oriented cold-rolled steel as contrasted to the hot-rolled steel formerly used. When the magnetizing current is interrupted before current zero, the energy available in an oriented steel core is substantially less because of the lower magnetizing force and the higher core remanence. Calculations indicate that even when the magnetizing current is interrupted at its peak, voltages reaching twice normal will be rare.

Since lower BILs appear to be inevitable, transformer dielectric tests should be examined to make sure they are adequate. Phase-to-phase tests and corona tests require discussion.

As BILs and low-frequency tests are reduced, the ratio of low-frequency test to maximum phase-to-phase operating voltage comes into the 1.5 to 1.7 range at "1-step-down" for most system voltages where reduced BILs are considered. This degree of reduction is being considered by industry committees as a reasonable limit and undoubtedly will soon be reflected in transformer standards.

The authors believe it is not too early to give serious consideration to some form of corona measurement during transformer low-frequency tests at the factory. Tests on over 50 power transformers during the past 2 years have served to identify the problems and indicate practical solutions. It has been concluded that a variation of the NEMA (National Electrical Manufacturers Association) RIV (Radio-Influence-Voltage) method is a practical test. The variation consists of using the high-voltage bushing capacitance tap in place of the coupling capacitor in the NEMA circuit which is bulky, expensive, and must be located nearby and connected to the transformer by a corona-free lead.

A major problem in making transformer corona tests is "background noise." A substantial offender is the sphere gap used and its series resistors and connecting leads. The sphere gap has been the standard for high-voltage measurements for many years. It is exceedingly useful in a high-voltage laboratory where it can be expected to be used and maintained by expert operators who have a proper recognition of its limitations. In a factory test area it is cumbersome, and time-consuming to use and is often found to be surprisingly inaccurate. Again, the solution to the problem is found in the high-voltage bushing capacitance tap. By using readily available crest-reading voltmeters, voltage measurements with the capacitance tap can be made during transformer insulation tests with an average error of less than half that achieved with spheres.

In considering a transformer corona test, it must be decided at what voltage the test will be made, and what limiting RIV values should be met. If it is assumed, as some claim, that one purpose of corona testing is to guard against unrecognized damage during a low-frequency test on the transformer, then, obviously, corona measurements should be made at maximum low-frequency test voltage. On most high-voltage transformers this is the induced voltage test.

Since, on induced voltage test, the voltage is 2.5 to 3.5 times normal, and the frequency is usually between 4 and 7 times normal, substantial microvolt readings must be expected even on a transformer which is essentially corona-free. In fact, with only moderate "background noise," the microvolts on induced test may be hundreds of times the microvolts at operating voltage and frequency.

Further knowledge of switching surges with an accompanying improvement in arrester protective levels will permit further transformer insulation reductions, line-to-ground. The probable maximum reduction is "4 steps." An adequate corona test will aid in assuring transformer reliability.

Digest of paper 60-80, "Dielectric Tests on Transformers as Influenced by Further BIL Reductions," recommended by the AIEE Transformers Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Jan. 31–Feb. 5, 1960. Published in AIEE *Power Apparatus and Systems*, April 1960, pp. 99-110.

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A New Naval Facility for Measuring Low-Level Magnetic Fields

W. W. ANDERSON

Recent advances in naval undersea warfare have brought increased emphasis to the measurement and reduction of even the very low-level d-c magnetic fields which Naval ships may produce. A description is presented of one part of the U. S. Navy's current effort in this area, a new Magnetic Field Facility at the Navy's Engineering Experiment Station in Annapolis, Md.

THE primary mission of the U. S. Navy's new Magnetic Field Facility is to aid in the research and development of magnetic countermeasure devices and low magnetic field shipboard equipment and to provide a means of rapid testing and analyzing of prototype equipment under actual running conditions and prior to permanent installation in the fleet.

The primary instrumentation system which is used at the Facility has been designed to measure the vertical component of magnetic field intensity below the items which are being studied. The output of the system is digitized and recorded on punched paper tape in the same format as that which is used by the digital computer present at the Engineering Experiment Station. Extensive use is made of the computer to perform different analyses on the measured field data for each particular experiment.

GENERAL DESCRIPTION

THE NEW FACILITY, shown in Fig. 1, consists of a main test building, a service building, and a long service tunnel which connects them together. The service building is the terminal point for all general services used to operate the test building and the equipment within it. In addition, the service building houses special-purpose equipment, such as air compressors, rectifiers, and load banks needed to operate the equipment under study in the test building. The service tunnel provides access for all these services to the test building and also provides a connection between the two buildings for personnel.

The main test building, shown in Fig. 2, houses the equipment under study and the instrumentation necessary to measure and record magnetic field data. The building has four levels: the top one is used for the major part of the instrumentation and the experimental setup; and the lower three, the second level of which is shown in Fig. 3, are used to support the probes which measure the magnetic fields produced during the experiment. The roof is elevated 20 feet above the main test floor and each level is 10 feet away from the nearest adjacent level. Additional probes are supported on a dual rotating and elevating boom assembly, shown in Fig. 4, the bottom boom of which is oriented on the center line of the building parallel to the plane of Fig. 2.

Because of the low levels of magnetic field which are measured in the building, it is necessary that the distortion by magnetic materials of the ambient earth's field and the fields produced during an experiment be reduced to a minimum. This was accomplished by constructing the test building entirely of materials which have a relative permeability of less than 1.02.

To meet the stringent permeability requirements, the building was designed around the use of a heavy concrete base support reinforced with aluminum rods and large 40-foot laminated wooden beams located on each floor (Fig. 2). Increased flexibility as well as conformance to the low permeability requirements were provided through the use of lightweight aluminum gratings on each of the probe levels (Fig. 3). The walls were constructed of cinder block reinforced with aluminum mesh. The roof was made of large cuts of composition

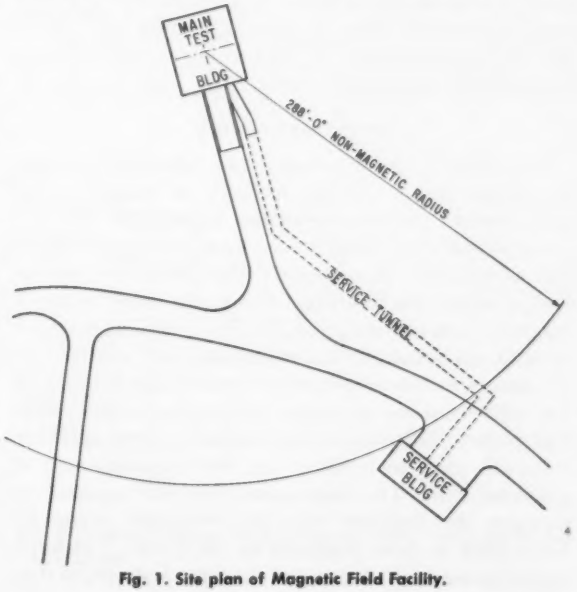

Fig. 1. Site plan of Magnetic Field Facility.

A special article recommended by the AIEE Marine Transportation and Special Instruments and Auxiliary Apparatus Committees.

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The opinions or assertions made in this article are those of the author and are not to be construed as official or as reflecting the views of the Department of the Navy or the Naval Services at large.

The author wishes to thank his associate, A. D. Beary, Jr., for the assistance rendered by him in the preparation of this article.

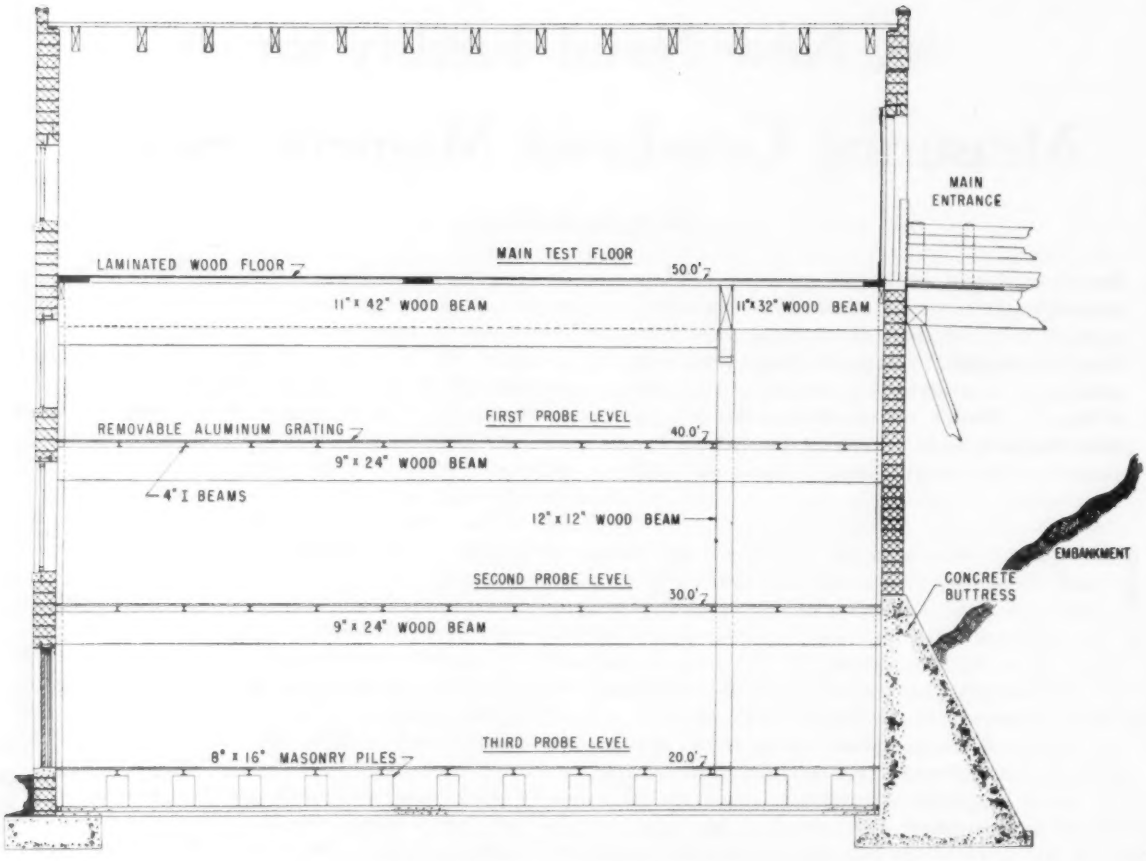

Fig. 2. Cutaway side view of test building.

material laid across wooden beams which run the full width of the building.

The same permeability restriction was also placed upon any materials used within the 288-foot "nonmagnetic" radius shown in Fig. 1. To insure that this area was magnetically clean, a series of borings were taken and a magnetic survey of the area was made with a conventional land mine locator.

INSTRUMENTATION

SELECTION of the instrumentation involved considerable study of the current methods of magnetic field measurement and the particular equipment which is available on the market today. From the beginning, it was known that the complete instrumentation system had to satisfy the following criteria. In order to locate magnetic field sources accurately, the system had to have at least a resolution of one gamma (10^{-5} oersted) on the most sensitive range and an error of less than 3% of full scale value on all ranges. The measurement probes had to be unidirectional because most naval specifications are made in terms of the vertical component of magnetic field. The instrumentation was required to measure the absolute value of completely static d-c fields, such as those produced by the presence of ferromagnetic material. Because of the large amounts of data that would be gathered in a single test, the complete system had to provide rapid and reliable measurements along with permanent records of the measurements with almost completely automatic operation. Finally, it was highly desirable that a major part of the instrumentation be made of existing "on the shelf" items to facilitate maintenance, interchangeability, and future additions.

The final selection was a system that used the well-known fluxgate or second harmonic type of magnetometer which is manufactured by the Institute Dr. Foerster, in Reutlingen, West Germany, and sold in the United States by the Magnaflux Corporation in Chicago, Ill. [1, 2]

Fig. 5 illustrates a simple monoprobe system using the fluxgate magnetometer. The measurement probe is about 16 inches long and 2 inches in diameter. The actual sensing element of the probe is only 1.2 inches long and 0.2 inches in diameter. The element is oriented so that the component of magnetic field along the axis of the probe is measured. Because of its small size, precise point measurements of field intensity are possible. The remainder of the space in the probe is used for terminal connections and provisions for alignment adjustments.

As shown in Fig. 6a, the probe sensing element consists of two easily saturated permalloy magnetic cores,

each of which has been wound with two separate windings. The two windings which form the primary windings are connected so that the flux in one core is in the opposite direction of the flux in the other. The two secondary windings are connected so that fundamental frequency voltages will cancel as a result of voltages of opposite polarities being induced in these coils.

A very stable a-c signal is applied to the primary winding by the magnetometer. If there is no d-c magnetic field present along the axis of the cores of the probe, the distorted wave forms of the two voltages V_{s1} and V_{s2} are symmetrical, and the net voltage of secondary windings V_s is zero, as shown in Fig. 6b. If however, there is a d-c magnetic field present, the two wave forms become asymmetrical because of the opposite saturation effects by the d-c field in the cores, and the net result, as shown in Fig. 6c, is a voltage on the secondary winding which consists primarily of the second harmonic of the a-c signal applied to the primary.

Within certain range limits, the amplitude of the second harmonic in this voltage is directly proportional to the d-c magnetic field intensity which causes it. Therefore, the probe input is fed to the magnetometer which eliminates all components except the second harmonic, amplifies it, and passes the resultant signal through a phase sensitive detector. This results in a polarity-sensitive d-c voltage which is presented both as a calibrated meter reading and as an analog voltage whose amplitude is directly proportional to the measured d-c magnetic field.

The system operates in an ambient field environment which consists of an earth's field of approximately 54,000 gamma and of fields produced by the experiments themselves which can vary to as high as 2,000 gamma. Since there is no intention of measuring these ambient fields, means of compensating for them was necessary before measurements of fields as low as 1 gamma would be possible. This was accomplished by passing controlled amounts of direct current through the probe compensation windings from two compensation sources, one a manual and the other an automatic source. The two compensation windings, shown externally in Fig. 5, are actually wound closely together

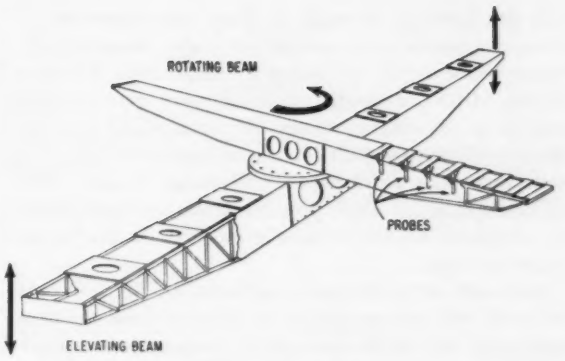

Fig. 4. Simplified drawing of dual boom assembly.

with other probe windings. The leads for these two windings are brought out with the probe output leads to the magnetometer and compensators in a single multiconductor cable.

The manual compensation unit consists simply of a highly regulated d-c power supply whose output current is controlled by manual adjustment of front panel controls. This unit is used to compensate for fields produced by the experiments which are not part of the field which is to be measured.

Because of random earth's field variations, automatic control of the earth's field compensation currents was provided. This automatic control was accomplished by using a separate earth's field reference probe located far enough away from the test building of the Facility so as to be unaffected by magnetic fields produced by equipment in the test building. In this case, the measurement probe is fed a current whose value is determined by the amount of magnetic field read by the earth's field probe. This results in the system's being compensated not only for the large constant magnitude portion of the earth's field, but also for the small daily variations in this field.

The complete instrumentation system for the Facility is shown in the block diagram of Fig. 7. The system has 11 magnetometers which are designated alphabetically

Fig. 3. Second test level of test building.

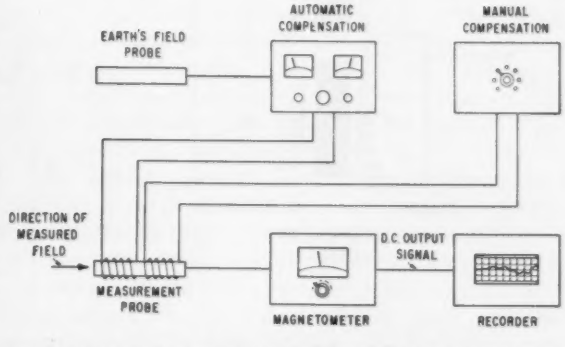

Fig. 5. Simplified diagram of a monoprobe system using the flexgate magnetometer.

with the letters A through K. Each magnetometer receives the output of a number of probes from the different probe levels by means of sequential scanning circuits which are designated in the same manner. The outputs of the magnetometers are scanned by a multiplexer and the net result is a single output for all points of measurement which presents a number of time coded d-c voltages in an order which enables an operator or the computer to determine the location of any of the probe readings.

Inasmuch as the amount of information per unit area decreases with an increase in the distance from the item under test, each of the three probe levels has correspondingly fewer probes as their distance from the top level increases. The first probe level, 10 feet below the main test level, has 97 probes with an equidistant spacing of 2 feet 10 inches arranged in an array which resembles an 11 by 11 matrix with 6 probes taken off each corner. The second level has 49 probes with an equidistant spacing 5 feet 8 inches arranged in a 7 by 7 matrix, and the third level has 25 probes with an equidistant spacing of 8 feet 6 inches in a 5 by 5 matrix. The three probe layouts are shown in Fig. 8.

Although there is a total of 171 probes, only 97 manual compensation units are used with the system. Switching circuitry is used to enable compensation of ambient fields on any one level at one time. Automatic compensation is in effect for all probes at all times and, therefore, does not require any switching.

Additional measurement points at intermediate levels between the three probe levels are provided by the dual rotating and elevating boom assembly, shown in Fig. 4. Mounted on one side of the upper boom are 11 probes spaced at equal intervals of 1 feet 5 inches with the innermost probe mounted directly over the center of rotation. The boom is rotated in 22½-degree increments for a total of 16 positions. The entire assembly is raised or lowered in 6-inch increments on a guide rail and pulley assembly. When a desired level is reached, the lower supporting boom comes to rest on preset stops precisely positioned to keep the boom level.

The digital-data handling system used with the instrumentation is fairly standard except for the identification cycle. Before magnetometer scanning is begun, a short identification cycle reads in a number of d-c voltages to the analog-to-digital converter which represent range settings, probe positions to be scanned, and a run designation. This information is punched on tape and then the regular data cycle begins.

The complete system has provisions for both manual and automatic operation. Manual operation is used to select specific probes for individual readings and to prepare the instrumentation for an automatic run. Automatic operation is used to gather the data on any one level rapidly and in a form readily interpreted by the computer. The information gathered during the automatic cycle is the primary source of data for the computer because of its consistency and relatively small error.

Final output of the system is in two forms, printed hard copy and punched paper tape. The printed hard copy consists of a column of three digit numbers with their signs. The punched paper tape is punched out in the format of the Bendix *G-15D* digital computer present on the station and, hence, is immediately applicable as input data to the computer.

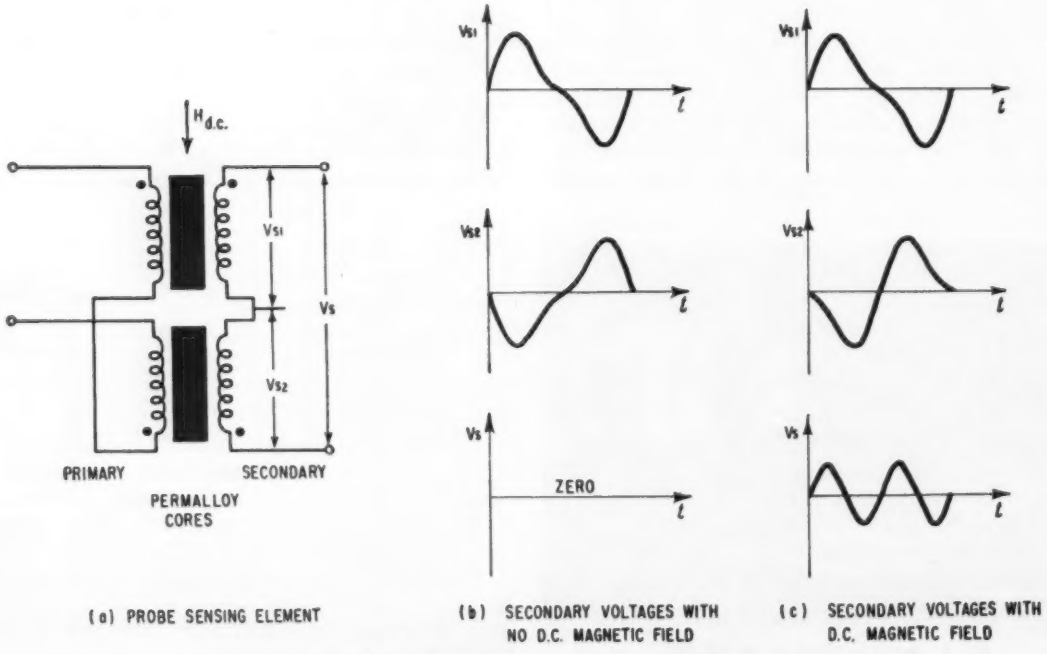

Fig. 6. Principle of operation of the fluxgate magnetometer.

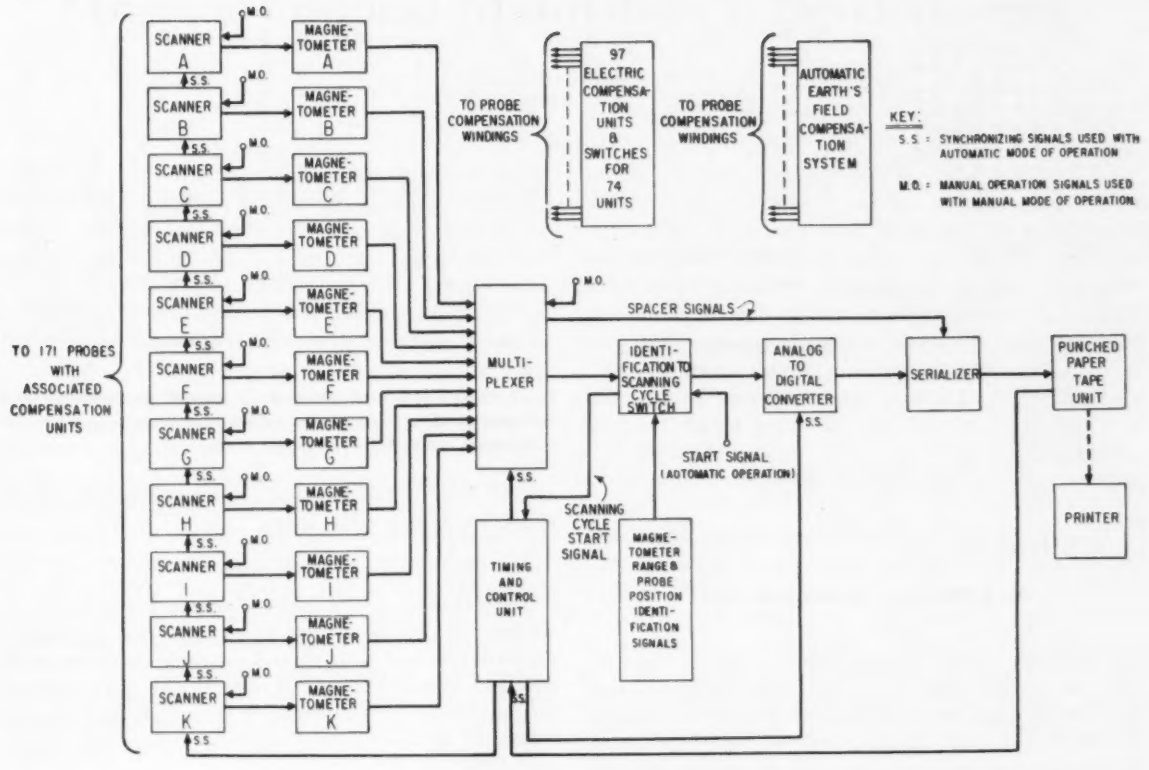

Fig. 7. Simplified block diagram of instrumentation.

DATA ANALYSIS

Currently, one of the most important problems at the new Facility is the location and identification of the major magnetic field sources within a field-producing item (e.g, various type shipboard electric equipment) from data gathered in a measurement plane below that item. Many other analysis problems are of interest to the Facility, but this particular one forms a major part of the Facility's efforts at this time.

Basically, three methods are being used to find solutions to the source location problem. The first of these consists of presenting the measured field data in contour form, such as the one shown in Fig. 9, and then visually comparing these contours with the contours of magnetic dipoles whose nature and locations are known. Here it is assumed that the magnetic dipole is a close enough approximation for most field sources. This method has been relied upon quite extensively in the past but has many obvious limitations. The most important of these limitations are that the method requires an inordinate amount of time to analyze the data compared to the time used to generate this data and that it depends upon subjective evaluation of the data. The former limitation should be emphasized because it illustrates an example of the common problem of being able to generate large amounts of data in a matter of minutes and yet having to take weeks or even months to analyze this data.

To overcome these problems, it was apparent that data analysis aids were essential. Both of the other two methods are presently under development at the Facility and make extensive use of the Bendix *G-15D* digital computer. The first of these is a more sophisticated version of the old method of contour comparison. The contour of the unknown field source is first approximated using the digital computer by a third- or fourth-order equation in the x and y co-ordinates of the measurement plane. The coefficients of this equation will then be used to describe the contour mathematically. The computer will be programmed to search for the coefficients of contours with known field sources which most closely match those of the contours with the unknown field source. As the search progresses, the computer will automatically modify various coefficients to include changes in orientation, currents, locations, and ferromagnetic materials. The final answer will give the known contours with which the unknown contour compares most favorably and will show the changes which were necessary to make the comparisons.

The second approach is a radical departure from previous methods of solution. It assumes no prior knowledge as does the first approach and, hence, will be able to achieve a solution solely from the measured field of the unknown field source. First, it is assumed that most field sources will be current-carrying loops and that these loops can be represented as closed polygons composed of usually not more than five straight line segments, an approximation which is probably more accu-

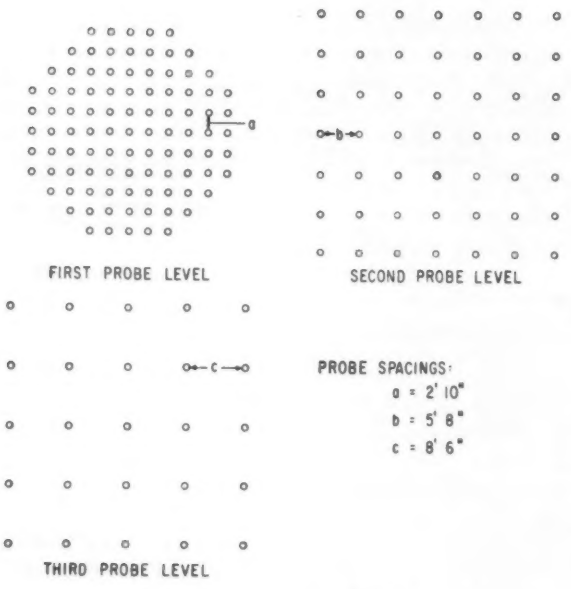

Fig. 8. Probe arrays on each probe level.

rate than the dipole approximation made in the contour comparison approach. A formula which describes the vertical component of magnetic field as a function of current, location of measurement, and location of the straight line segments has been developed and will be used with a method of successive approximation to reach a solution. The computer will select, either automatically or by manual control, the number of loops to be solved for and the number of straight line segments which will be used to approximate each loop. The final answer will be the location of the end points of the approximate polygonal loops.

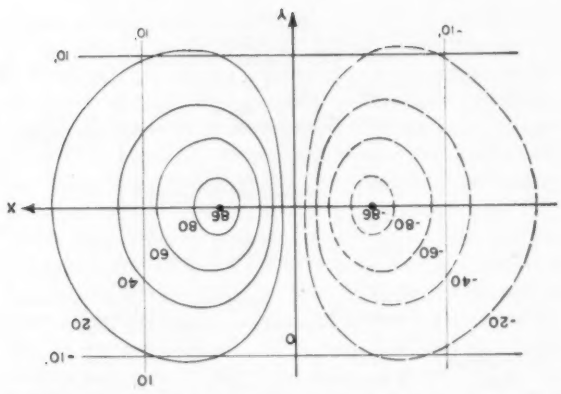

Fig. 9. Contour of vertical component of magnetic field produced by a horizontal dipole of moment M = 30,500 square-foot ampere turns on a horizontal plane 10 feet below the dipole.

CONCLUSION

THE CURRENT STATUS of the Magnetic Field Facility is an interim one. A smaller instrumentation system for use with the dual rotating and elevating boom assembly has been completed and is operational. Specifications for the primary instrumentation system are finished and a contract has been signed. Delivery is expected in January 1961.

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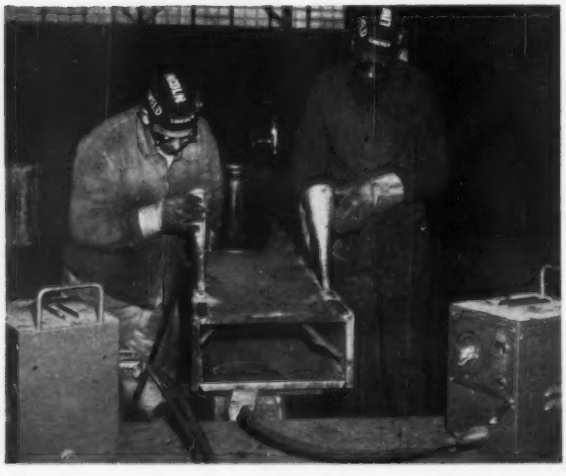
Fabricating Columns for United Engineering Center



These weldors are completing joints in one pass with the Lincoln Electric Company semiautomatic submerged arc process to fabricate box columns for the new United Engineering Center in New York City. Fabrication proceeds at Dreier Structural Steel across the East River in Long Island, as structural steel is erected at First Ave. and 47th St. in Manhattan. The 20-story $12-million 3,300-ton welded structure will be topped out in August. The box columns, fabricated from 1¾- and 1½-inch plate run the full height of the structure in the area of the elevator shaft to provide rigid load-bearing columns taking a minimum space.

General contractor is Turner Construction Company. Dreier Structural Steel Company of Long Island City is fabricating and erecting the steel framework. Architects are Shreve, Lamb and Harmon. Steelye, Stevenson, Value and Knecht are the structural engineers.

Magnetic-Coupled Multivibrator Developments

W. A. GEYGER
MEMBER AIEE

IN STATIC d-c to a-c converters employing a saturating transformer with rectangular hysteresis-loop core material in conjunction with two switching transistors (magnetic-coupled multivibrators), the oscillation frequency is linearly proportional to the d-c supply voltage. This fact is significant with regard to telemetering-transducer applications. However, the relation between d-c input voltage and frequency of the square-wave output voltage is quite unfavorable in those cases; e.g., design of test circuits for magnetic amplifiers, where it is necessary to vary the oscillation frequency of the magnetic-coupled multivibrator independently, without changing magnitude of the supply voltage.

It is possible to control the oscillation frequency of switching-transistor magnetic-coupled multivibrators by means of a direct bias current applied to additional windings of a twin-core arrangement, similar to that of self-saturating magnetic amplifiers, without changing magnitude of the output voltage. However, as a result of d-c bias magnetization of the cores, the output waveform deteriorates from its clean rectangular shape. This is undesirable in many applications of such d-c to a-c converters.

Recent investigations on differential-type magnetic-coupled multivibrators have shown that the output frequency of such arrangements can be varied within wide limits, without changing the magnitude of the output voltage and without impairing the output waveform, simply by connecting a square-loop-core saturating reactor in parallel to the load or across the collector terminals. Continuous linear frequency control can be achieved by introducing a standard low-power adjustable transformer connected across the load or across the collector terminals.

Because the fundamental principle of this new method for wide-range frequency control consists in loading the original differential-type circuit by means of a square-loop-core saturating reactor determining the output frequency of the multivibrator, this reactor should have a very small copper resistance of its tapped winding. For this reason, it is convenient to provide on this reactor several groups of equally-rated (preferably bifilar-wound) windings, which may be used either series- or parallel-connected to vary the oscillation frequency step-by-step over wide ranges.

In order to obtain optimized switching performance and to minimize "spikes" in the output square wave, magnetic-leakage effects must be reduced to the minimum. When using the ratio $N_1/N_2 = 1/2$ between the number of turns of the feedback windings N_1 and that of the main (primary) windings N_2 of the differential-type multivibrator circuit, the transformer of this circuit can be considered to have $N_1 + 2\,N_1 + 2\,N_1 + N_1 = 6\,N_1$ turns acting as collector windings ($2\,N_1$) and emitter windings (N_1), respectively. In this way of design, six twisted wires may be handwound simultaneously around the core of the transformer which then has negligible magnetic leakage between its winding units.

Although the transformer with windings N_1 and N_2 is always unsaturated with higher frequencies, it will operate with the lowest frequency between saturation levels, in accordance with the mode of operation of conventional multivibrator circuits. It is, therefore, advisable to employ rectangular hysteresis-loop core material also in this transformer, if the lowest part of the frequency range is to be utilized. However, when working only in the upper part of the frequency range, where the saturating reactor is the frequency-determining component, the transformer with N_1 and N_2 acting merely as an isolation transformer will never be saturated and will have correspondingly reduced core losses. In this case, lower-grade core material may be used in this transformer.

With regard to high-frequency operation of magnetic amplifiers, the new multivibrator circuits have been investigated at high output frequencies, up to about 100,000 cps. In this case, eddy-current losses in the saturating core must be reduced to the minimum by using small 4-79 Molybdenum Permalloy bobbin cores (tape width = 1/8 inch, tape thickness = 1/2 mil, 1/4 mil, or 1/8 mil, respectively). Measurements on a prototype design have shown that the circuit efficiency, i.e., the ratio between output power and input power, is about 60 to 65% with the output frequency 50,000 cps. In the most interesting frequency range of 10 to 50 kc, a quite acceptable trapezoidal waveform is obtained, which is suitable for high-frequency operation of magnetic amplifiers; e.g., self-balancing magnetic amplifiers operating as audio amplifiers in conjunction with crystal radio receivers or standard turntable equipment.

Because output frequency of the new multivibrator circuits can be made directly proportional to angular position of an adjustable-transformer slider shaft, these circuits may be used in telemetering transducer applications. In this way, angular (or linear) displacement can be converted to a corresponding frequency shift. Movement or rotation of the shaft may be controlled remotely with a conventional servo system.

Digest of paper 60-96, "Recent Developments on Magnetic-Coupled Multivibrators," recommended by the AIEE Magnetic Amplifiers Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Jan. 31-Feb. 5, 1960. Published in AIEE *Communication and Electronics*, May 1960, pp. 106-12.

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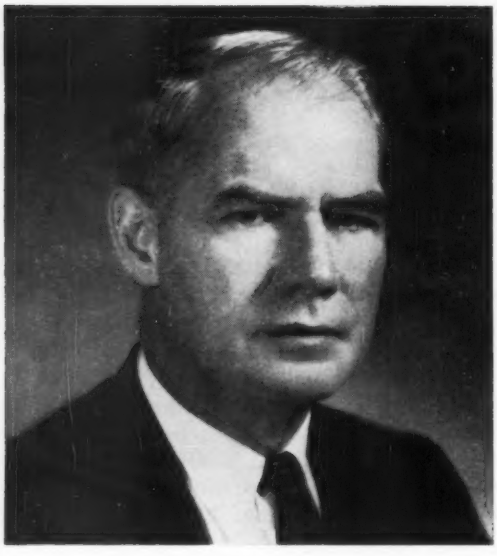

Lee A. Kilgore

1959 Lamme Medalist

History of the Medal

J. H. CHILES, JR.

FELLOW AIEE

THE LAMME MEDAL, which we award today, is a significant reminder of some of the greatness that existed in the early days of the electrical manufacturing industry in the United States. Brilliant men with amazing foresight made use of their talents to revolutionize American industry and the living habits of the American people.

Among the foremost early practitioners of perfection in the electrical design field was Benjamin Garver Lamme, an Ohio farm boy who became chief engineer of the Westinghouse Electric and Manufacturing Company, now the Westinghouse Electric Corporation.

Mr. Lamme, a design and development engineer, was a modern pioneer in his field. He designed the single reduction railway motor, the machines exhibited at the Chicago World's Fair, the generators which inaugurated hydroelectric power at Niagara as well as those for supplying power to the elevated and subway systems in New York City, and the equipment which operates the New York, New Haven and Hartford Railroad.

These and other accomplishments brought him widespread recognition, not the least of which was presentation of the Edison Medal by the American Institute of Electrical Engineers in 1919.

Mr. Lamme's greatness, however, is measured more by the fact that he did not stop at the development of his own mind and talent. During his later years, his overriding interest was in the selection and training of promising young engineers, and in the development of a heightened awareness among his contemporaries of the need for advancing the engineering profession through education and through incentives toward better living for mankind.

This interest led to the establishment of the Lamme Medal at the death of Mr. Lamme in 1924. The purpose of this coveted award is to give recognition to AIEE members who have shown "meritorious achievement in the development of electrical apparatus or machinery."

To qualify, the work can be in the development of the theory involved, in the development of the characteristics of the material employed, in the development of the over-all design, or in development in other ways, resulting in substantial improvement in electric apparatus or machinery.

As chairman of the Lamme Medal Committee of the AIEE, I feel certain that the choice of Lee Kilgore for the 1959 award is in keeping with the highest traditions of the award and of Benjamin Lamme.

Career of the Medalist

J. F. CALVERT

FELLOW AIEE

IT WAS with some hesitation that I accepted the privilege of presenting a résumé of the career of the Medalist because I am certain of a number of men who have been more intimately associated than I with Dr. Kilgore's most recent engineering contributions. Still, in respect and admiration for his over-all accomplishments I can yield to none and, therefore, shall seek to refresh the memories of a few and to set forth for others some of his work leading up to this present event.

In 1927, Lee Alton Kilgore was graduated from the University of Nebraska, first in his class, and proceeded from there to the Westinghouse plant at East Pittsburgh. He worked for a few months in the power engineering design department and studied on the student training program. His last student training assignment was for 6 months in the old design school. There, he was recognized by teachers—themselves designers—as one of the most promising men seen in a decade. And, from those student groups have come designers, consultants, chief engineers, and others known throughout the profession. From Dr. Kilgore's own group has come, recently, another Lamme medalist.

Presentation and acceptance addresses given at the general session of the AIEE Summer General Meeting, Atlantic City, N. J., June 19-24, 1960.

J. H. Chiles, Jr., is with the Westinghouse Electric Corporation, Sharon, Pa.

Within 2 years after this training period, Lee Kilgore completed his first major engineering task—the development of his procedures for calculating all the various reactances and time constants of synchronous machines. His publications on these subjects stand as milestones. His ideas, then new, are today proved by experience, and continue in full use.

Immediately after completing the design school, he undertook evening graduate studies, and received, in 1929, the degree of master of science in electrical engineering from the University of Pittsburgh. In 1934 he received the EE degree from Nebraska, and in 1956 his Alma Mater brought him home to Lincoln to receive an honorary degree: Doctor of Engineering.

Shortly after his reactance studies were completed, he was granted patents on two of the three types of double-armature windings devised to yield equal vector voltages, with only slight electromagnetic coupling between the two windings, although these were mounted in the same armature punchings.

There followed a series of inventions and papers on varied subjects. I shall mention only areas. Patents were granted on low-loss machines, vapor electric devices, impulse generators, oscillation generating systems, multiple-pressure blower systems, ventilation in turbine-generators, variable-speed a-c drives, and rectifier anodes. These, I hope, will call to mind some of the diverse areas in which he has done creative work.

In the middle 1930's, he was assigned the task of developing new and better design procedures for each type of large a-c rotating machine then built by his company, and, also, for mercury-arc rectifiers. Within his own organization, at least, these works remain as milestones of progress.

Over a period of years he designed and built wind-tunnel drives and their speed controls. In 1940, there appeared the 40,000-hp doubly fed induction motor for Wright Field. Experiences with this equipment induced Dr. Kilgore to study aerodynamics. This study resulted in a report of limited but significant circulation, which presented graphical techniques for mapping the flow of gases around air foils, propeller blades, and solid objects of related forms. Then there followed a 36,000- and a 50,000-hp installation for Moffett Field, Calif. Still later, he supervised the design of the 216,000-hp wind-tunnel installation for the U. S. Air Force base at Tullahoma, Tenn.

Dr. Kilgore was invited to design the power supply for a large particle accelerator for Brookhaven, and another for the University of California. These called for large pulses of power at closely defined time intervals. In neither case could the power demand be supplied directly from the utility system because of the regulation and stability difficulties which would ensue. These problems foreseen, he designed an interposing flywheel-motor-generator-ignitron converter set, with the output of the ignitron supplying the pulsed power. At the end of each pulse, electromagnetic energy is re-stored as kinetic energy for use in a subsequent pulse. Various load requirements added to the difficulties of design.

Beyond both his citation and these further works touched upon by me, there are contributions to the art and to the Institute, which I shall omit in favor of some other views of his career that I feel impelled to mention.

He has, I believe, received inspiration from his church work, experience from his civic activities in a small community, and encouragement from his family—most of all from his wife, Ellen. Each has contributed in some special way to the maturing judgment, strength, and kindness of this man whom, over the years, we have learned to value so highly.

And then a different view comes to mind. In many ways, I feel that his present position as director of engineering at East Pittsburgh appropriately names him today's successor to the responsibilities of Mr. B. G. Lamme, for whom this present award was named. The work and thought of these two men bear certain resemblances. Both have exhibited remarkable powers for visualization, for invention, and for design. And, like Mr. Lamme, Dr. Kilgore has had a great desire to seek out and to teach young men of promise in true design. In more recent years, through both formal and informal training, he has sought to enhance young men's creative abilities. Dr. Kilgore has proved to be a great sculptor of machines who could envision equipments and their performances where nothing stood before; and he has developed men. His younger associates have seen in him not only the spirit and art of design, but also the soul of integrity and unselfish purpose. They have seen him defend a point, accept responsibility, and give credit where credit was due. So, through formal and informal training, his ways of work and his ways of living are reflected today in the lives of many who have been his students and associates of former years.

A worthy citizen, a master builder, and an exceptional teacher—Dr. Lee Alton Kilgore.

"For meritorious achievements in the design of electrical machinery; more specifically, for analyses of synchronous machine reactances; for inventions of special armature windings; and for inventions and designs related to large adjustable-speed alternating-current motors."

J. F. Calvert is with the Department of Electrical Engineering, University of Pittsburgh, Pittsburgh, Pa.

Power Engineering in the Future

L. A. KILGORE

FELLOW AIEE

I APPRECIATE Dr. Calvert's kind words, for it was he who by encouragement and example got me off on the right foot as a beginning engineer. It is indeed a privilege to be awarded a medal for what I so thoroughly enjoyed doing in the first place. To be included with those who have been awarded the Lamme Medal by the AIEE is an honor greatly appreciated. I have known several of these recipients personally, and it seemed to me they greatly enjoyed their work and their contacts with others interested in their work. Mr. Lamme himself exemplified to the highest degree this interest in his profession and in his fellow engineers.

It was not my privilege to know Mr. Lamme personally, since I entered the profession just after his death, but I feel I owe him a great deal for he left a great heritage of design philosophy. More than that, he left a group of associates highly motivated for technical accomplishment. Following his example, these men were also dedicated to training young engineers to carry on the advance of engineering knowledge. It is this heritage left us by Mr. Lamme and other leaders that has made possible the power industry which is contributing so much to our present standard of living.

Since Mr. Lamme's death 36 years ago, the power industry has grown in capacity tenfold. I have had the privilege of watching this growth and being a part of it both in the design of large generators and in the application of power through large motors and rectifiers. For this reason, it is the power field of engineering about which I want to talk.

We get in the habit of thinking that the power industry is going to double every 10 years. But when we stop to think that this would mean another tenfold increase in the next 36 years, it is a bit hard for us to conceive of what form it would take and where the load is coming from. So we wonder: Can we count on this continued growth or are things going to level off?

When I was a student engineer, a manager once had me copy some curves from a British magazine showing the historical S-shaped growth cycle of some industries which had finally saturated. This article showed the future of the power industry about to flatten out in 1930. For a few years after that, during the depression, it almost looked like the author was right, but not for long.

In examining such a trend we cannot hope to see every step in the future—all we can do is examine the dynamic forces behind the trend. The same dynamic factors which have doubled most industries every 20 years and the power generation industry every 10 years are still at work. The increasing standard of living and the increased mechanization and automation of industry and services are two powerful dynamic forces still at work. The expanding need for chemicals, materials of all kinds, and water for irrigation and industry will carry the load curve on up for many years to come. We can look for further developments in the electrochemical and electrometallurgical fields. Two big factors of the near future we can see clearly; these are the growth of air conditioning and electric heating. Even lighting, and especially highway lighting, is still a growing load. We cannot see new inventions ahead comparable to radio and television, but they will come—for our research and development efforts have been increased manyfold. Many large manufacturing companies definitely recognize that they are going to have to have new products for the future. It may be hard for us to conceive, but barring a catastrophic war, we can expect the next 36 years to bring another tenfold increase in power.

Even though most of us accept this long term load growth, we are inclined to think that one factor or another has finally reached a limit. This is usually because we can't see the next step clearly. We see the limiting factor, but we don't see the way around it which has not yet been invented. Only about 10 years ago when we planned some major new facilities, someone advised us that we need not expect to build units larger than 200,000 kw in the next 20 years. Fortunately we aimed higher and, by developing inner cooling, we found a way around the limitation. This development was indeed fortunate, because we had about reached the limit in size of rotors due to allowable stress. Thus, this development more than doubled the capacity in one stroke. We have already shipped single generators of 326,000 kw rating at 3,600 rpm and could now build a generator of about 600,000 kw capacity. Somewhere beyond this, we will need another breakthrough, and I

Shown at Lamme Medal presentation ceremonies held at the AIEE Summer General Meeting, Atlantic City, N. J., on June 20, are *(left to right)* J. H. Chiles, Jr., chairman, Lamme Medal Committee; L. A. Kilgore, Medalist; AIEE President J. H. Foote; and J. F. Calvert.

L. A. Kilgore is with the Westinghouse Electric Corporation, East Pittsburgh, Pa.

am sure it will come. However, we will need the very best engineering talent to do it.

The trend to larger, more efficient and more economical steam units will continue. This future development may involve new materials. In talking with our research people, I am reminded that our highest-strength rotor steels have one tenth the strength of a single crystal of steel, and the best composite electrical insulation has only one tenth the dielectric strength of pure mica. This means we still have a lot of room for improvement. Even though it will be very difficult, progress will come in the basic materials.

Mr. Lamme was one of the very first to apply science and analysis to electrical machine design. The science of design has been extended. The rapid growth has demanded ever larger and more efficient units and this in turn has demanded much innovation in design and construction. However, really complete analysis and optimization of designing have been limited in the past because we had to use all of our ingenuity to oversimplify the design method to get any reasonable calculation which could be done accurately by hand. Now we can apply all the science and refinement of analysis we know and assign the burden of the long calculations to an electronic computer. Actually, the design of electric equipment is entering a new era. The computer is going to augment brain power just as machines have augmented muscles in the past century. And in repetitive calculation and clerical work, the computer will take over, just as automatic machines have more recently taken over the repetitive manual jobs.

Let us indulge in some speculation on the possibilities in the future of the power industry. There may be major changes in the methods of generating electric power in the future. Fuel cells and thermoelectric and magnetohydrodynamic generators all offer some possibilities, but there are many very difficult problems, particularly in materials. It seems likely that the major portion of the kilowatt capacity installed in the next 25 years will still be in the form of rotating generators, whatever the prime mover or the fuel may be. Should these new forms of power generation prove practical, they will very likely require conversion from direct to alternating current by solid-state inverters. Frequency conversion, as well as rectification, will very likely be taken over completely by semiconductor devices, which are still only 12 years old. This will lead to the general use of brushless exciters and new types of variable-speed drives.

There will be a great deal of engineering analysis applied in the future to operating problems. On-line digital computers will take over the job of starting, operating, and controlling the ever more complicated power stations, as well as large industrial processing plants. There are real economies to be gained in more perfect dispatching and control, just as there are in the more perfect optimization of machine design. All of this automation of analysis and of operation will free the engineer to apply his talents to a more profound study of better systems as well as better apparatus.

The transmission and distribution of power must keep pace with the growth in kilowatt capacity. Higher voltages are inevitable, but in transmission series capacitors and shunt reactors will also be used with other advances in maintaining stability. The trend toward interconnected system operation, whereby neighboring utilities can benefit by exchanging substantial load, will ultimately permit taking advantages of east–west differences in time zones and north–south differences in seasonal peaks.

The more powerful close-coupled systems will demand more powerful circuit breakers to protect them. Here is a field where the scientific attention just now being applied in the military field to plasmas can be put to practical use. In circuit-breaker arcs we have been dealing with plasmas for years and should welcome this new scientific interest.

Let us consider the kind of engineers that are going to be needed in this expanding power field. The difficult problems mentioned are evidence that we are going to need engineers who have not only a thorough training in fundamentals, but also have imagination and are motivated to create new devices and new systems. Even though the computer takes over some of the drudgery of involved calculations, it demands an even greater share of ingenuity and effort in designing the programs. This may well mean that in the future we will require not many more engineers, but better engineers. Our engineering schools have done an excellent job in the past in teaching the disciplines of engineering, and more recently have emphasized fundamentals. I hope in the future they can do more to teach creativity, or at least to keep alive the spark.

I have some real concern that we are not attracting the right kind of young men in sufficient number into the power field of engineering. We can all help by thinking about the future, and then interesting certain promising young men by showing them what we are doing today and telling them about the challenges of the future.

Actually, when we stop to think of the future of power engineering we see that the potential is there. It is up to us to develop it. No engineer in the power field nor any student entering the field should ever feel that he can in his lifetime run out of problems—problems which are so challenging as to demand his best efforts and ability.

SUPPORT THE NEW UNITED ENGINEERING CENTER

Aging of Wire Enamels in Transformer Oil

G. F. LIPSEY
MEMBER AIEE

P. W. JUNEAU, JR.

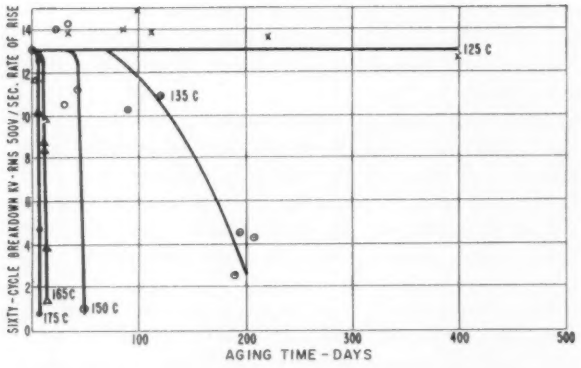

Fig. 1. The effect of aging in transformer oil with dry paper (<0.1 % H_2O) on the dielectric strength of Formex insulated wire. Tests made in 105 C oil.

THERMAL aging characteristics of wire enamels aged under conditions similar to those which may be expected in sealed liquid-filled transformers have been studied and found to be quite different from results obtained by aging the same enamels in air. Enamels which have shown only fair thermal aging characteristics in air in comparison to other enamels may rate very differently when aged in a sealed system with a limited amount of oxygen present. For example, Formex (General Electric registered trademark) wire enamel which has a short life in comparison to a terephthalate polyester when aged thermally in a circulating air oven is equal or superior to the terephthalate polyester when aged in a closed system under oil.

The presence of other materials such as the cellulose insulation and the amount of moisture present in the system are also factors which have a definite bearing on both the life and the chemical stability of the enamels. When paper is present in the wire-enamel aging tube, aging at high temperature causes the dielectric breakdown characteristics of the enamel to drop to a low value in a relatively short time. In hydrolytically stable enamels such as the polyvinyl formal/phenolic (Fig. 1), urea formaldehyde epoxy, and acrylic, it is caused principally by absorption of water formed by decomposition of the paper. The enamels that are less stable to hydrolysis, such as the polyesters, polyurethanes, etc. are affected to such an extent that they are chemically attacked by the paper decomposition products and degraded to low molecular weight fragments.

Fig. 2 shows the sample and aging container used in this study. It consists of twisted wire pairs coated with the enamel to be studied, with and without Kraft paper, and a strip of core steel sealed in a glass tube with transformer oil. The dielectric strength of the wire pair measured at 105 C under oil was used as the means of studying the aging characteristics of the enamel.

Accelerated aging data reveal that:

1. Formex wire insulation has excellent thermal stability in a sealed system under oil.
2. Formex wire insulation has outstanding resistance to moisture and hydrolysis.
3. Decrease in the dielectric strength of Formex wire in a sealed system with cellulosic insulations is due to absorbed moisture rather than chemical degradation.
4. Film continuity of the aged Formex wire is not affected and subsequent moisture removal by simple drying essentially restores its initial dielectric strength.

To sum up: a sample construction and container have been developed which permit the aging of enameled round wire in a simple and convenient manner. The methods developed provide the means of evaluating wire enamels with respect to moisture sensitivity and electrical life in an environment simulating that found in a sealed liquid-filled apparatus.

The data here presented indicate that in a system comprised of enameled wire, cellulose insulation, an insulating oil, and varying conditions of dryness, the ability of the wire enamel to function satisfactorily is dependent upon both its hydrolytic stability and its dielectric strength characteristics in the presence of moisture.

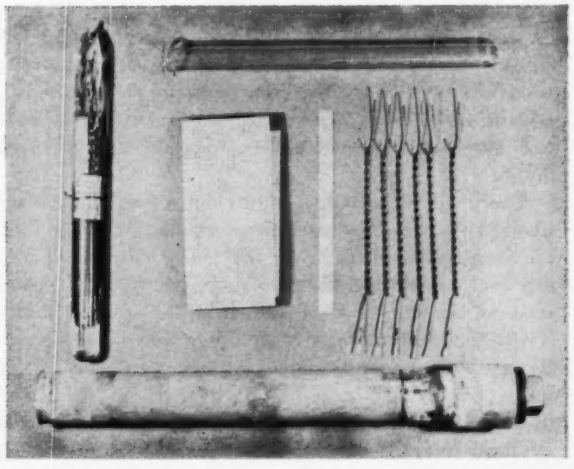

Fig. 2. Aging container and contents.

Digest of paper 60-86, "Factors Affecting the Aging Characteristics of Various Wire Coating Materials in Transformer Oil," recommended by the AIEE Electrical Insulation Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Jan. 31-Feb. 5, 1960. Published in AIEE *Power Apparatus and Systems*, April 1960, pp. 73-77.

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Shipyard Radiological Safety as Related to Nuclear Submarines

J. E. LOGSDON

An outline of some of the methods and procedures that are used to insure safe working conditions in radioactive work areas.

THE Electric Boat Division of General Dynamics Corporation has been working with radioactivity in one form or another for many years without an accident involving exposure above normal limits. This has been due to planning ahead, employee education, and the monitoring procedures used by the Division. Electric Boat, whose principal product is submarines, has 10,000 employees. The health physics department of the company keeps extensive records on radioactive material, radioactive areas, and personnel exposure to ionization radiation. A brief review of the history of man-made radioactivity will show the need of a radiation safety program.

Prior to the time of man-made nuclear explosions and nuclear reactors, there was only radioactivity that occurs naturally, such as cosmic radiation and radiation from radium. We now have in addition, tremendous quantities of radioactive material generated by the process of fission. Fission produces radioactivity in two ways:

1. When an atom fissions, it splits into two or more smaller atoms plus some neutrons. These smaller atoms are called fission products and they are highly radioactive.

2. Some of the neutrons that are produced in the fission reaction hit the nucleus of atoms of other materials such as iron, cobalt, or nickel and cause these atoms to become radioactive. It is generally true that any material which is exposed to a neutron flux becomes radioactive. (Many times it is erroneously assumed that the radioactivity is what causes the reactor to operate. Actually, in a reactor built for power generation, the radioactivity is simply an unwanted by-product.)

Therefore, our most frequent encounter with radioactive material is with the activated metals that are eroded and carried by the primary coolant and deposited on the walls and in crevices of piping. The gamma rays from this radioactive material penetrate the piping and cause the area in the vicinity of the pipe to be radioactive. If the pipe is cut open, the radioactive material, being exposed, is called radioactive contamination and may be transferred from one place to another as any other dirt would be transferred. In general, the small quantities that could be transferred as contamination would not create a significant radioactive area from the standpoint of external radiation, but small quantities are significant if there is a possibility of the radioactive material getting inside the body and radiating from the inside. There are then two types of radioactive areas to be concerned about. One is an area with a concentrated quantity of sealed radioactive material which causes the surrounding area to be significantly radioactive and the second is an area with loose radioactive material which could be ingested or otherwise introduced into the body.

FUNCTIONS OF HEALTH PHYSICS DEPARTMENT

THERE ARE TWO POSSIBLE WAYS of getting work done in radioactive areas. One way is to use only personnel with extensive training in nuclear physics and radioactivity; that is, personnel who have enough knowledge of radioactivity to work safely in its presence. Another way is to give the working personnel limited training and allow them to work in radioactive areas only under the direct supervision of personnel trained in radiological safety. Electric Boat uses the latter method and has found that it works out very successfully.

The personnel trained in radiological safety make up the health physics department, which is part of the industrial relations activity. There are also technical advisors from the radiation analysis group in engineering to whom the health physics department may go for information on shielding problems and other problems of a technical nature. The health physics department is made up of 2 health physicists, 4 supervisors, 24 monitors, and 10 clerks. It is the duty of health physicists to outline procedures to be followed in order to guarantee safe working conditions in radioactive areas. There is one supervisor in charge of the clerks and one supervisor on each shift in charge of the monitors. It is the duty of the monitors to make sure that the safety procedures are carried out properly. The function includes:

1. Monitoring personnel working in radioactive areas to see that they have the correct protective clothing and correct personnel monitoring devices.

2. Preventing the spread of radioactive contamination from one area to another.

Essentially full text of conference paper, CP60-896, presented at the AIEE Summer General Meeting, Atlantic City, N. J., June 19-24, 1960.

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3. Keeping records of the levels of radioactivity in the different areas involved.

4. Keeping a daily record of personnel exposure through dosimeter readings.

It is the duty of the clerks to keep records of film badges and dosimeter readings and to carry out the area monitoring program.

A very important part of the health physics program is the special barge which serves as headquarters for the monitors. This barge is arranged so that it may be tied up alongside a ship requiring work in a radioactive or contaminated area. It is provided with facilities for issuing, monitoring, and decontaminating protective clothing. The barge includes equipment for personnel and material monitoring and decontamination, water decontamination, and storage of radioactive materials. Instrumentation for detection of air, water, and surface contamination forms a vital part of the barge's installations.

The other important part of the health physics department is the Health Physics Laboratory where the area monitoring program is carried out. The area monitoring program consists of water samples taken daily from the Thames River, the Groton Reservoir, and tap water. Rain water samples are taken when available. Occasional mud, plant, and shellfish samples are also taken. Daily background air samples are taken at various points throughout the shipyard. All samples are counted for gross beta-gamma activity.

Another function of the Health Physics Laboratory includes the keeping of records of personnel exposure and the developing of employee indoctrination programs. Each new employee hired into the company is given a lecture on radiological safety which contains an explanation of the procedures used by Electric Boat to maintain safe working conditions in radioactive areas in the yard. He is shown a film badge and a dosimeter and is given a brief explanation of how they work, how and when to wear them, and why they are used. (Film badges and dosimeters are personnel monitoring devices worn on the person in the vicinity of the chest for the purpose of detecting the radiation dose absorbed by the body. The film badge gives a permanent record of the man's radiation dose, while the dosimeter gives an immediate visible indication of the dose that the man has received.) The new employee is also shown an example of the signs used for marking radioactive materials and a sample of the rope used for roping off radioactive areas. He is told when he will be required to wear a film badge and when he will be required to wear protective clothing. Any questions that the employee may have are answered and he is given a small booklet which explains the meaning of radioactivity in simple terms.

METHODS OF CONTROL

THERE ARE THREE CATEGORIES into which radioactivity may be divided which require control. They are: (1) ionizing radiation coming from a sealed source, (2) surface contamination, and (3) air contamination. Electric Boat requires that film badges be worn in any radioactive or potentially radioactive area. By potentially radioactive, we mean any area that might become radioactive by accident.

When nuclear submarines are in for repairs, or undergoing trials, control points are established at the entrance to the pier to insure proper protection. These control points serve the functions of providing for issuing and collecting film badges and insuring that access to these radioactive areas or potentially radioactive areas is under supervision. Anyone entering these areas is required to pick up a film badge at the control point.

The submarines have automatic alarm devices installed to signal if there is any unexpected radiation. In addition to this, the health physics department makes routine radiation surveys on board the ship, twice per shift to see if there is any change. Areas found to be radioactive to an extent that a man may receive more than one tenth of the allowed daily dose are roped off and no one is allowed in unless he has a film badge and a self-reading dosimeter.

Certain areas around a reactor are known to be radioactive. Before any work is performed in these areas, complete survey is made which includes:

1. A check for radiation to determine the length of time that a man may work in the area. (This is done by measuring the average radiation in milliroentgens per hour with a radiation detection instrument and calculating how long the man can stay to get 50 milliroentgens. Fifty milliroentgens per day is the dose allowed at Electric Boat.

2. A check for contamination to determine the need for protective clothing (contamination is dust, dirt, sludge, or anything that is loose and is radioactive).

3. A check of the air to see if there are any radioactive dust particles in the air.

Assuming that radioactivity is found to be present in all three forms mentioned, the following procedure is followed for control:

The area is plainly marked radioactive, and a clean area is established at the edge of the radioactive area consisting of canvas on the deck and walls. Supervisors who have requested that work be done in the area, and the personnel who issue protective clothing are notified of the existing conditions. Supervisors are told to have the men who will be working in the area pick up a film badge, dosimeter, and protective clothing. The protective clothing consists of plastic shoe covers, nylon and rubber gloves, nylon coveralls, nylon hat, and a respirator all packaged in a plastic bag. The worker takes the protective clothing to the clean area which has been erected and dresses at the edge of the clean area. A health physics monitor is stationed at this point to see that the man has his film badge and dosimeter and that he is dressed properly. The man is advised as to approximately how long he will be allowed to work in

the area and of any unusual conditions to watch for. When the man comes out of the area the health physics monitor makes sure that he removes his protective clothing in such a manner that he will not get his person, personal clothing, or the surrounding area contaminated. His dosimeter is checked and if for some reason his dosimeter has gone off scale, his film badge is pulled and sent in for immediate processing. The man is checked with a geiger counter to make sure he did not get contaminated. If he should be contaminated (which is a very rare case) he is given another set of clean protective clothing to cover the contamination and prevent spreading any contamination to the surrounding area.

The man goes to the shower where he washes until he is no longer contaminated. If he is found to be not contaminated when he removes his protective clothing, he is instructed to return his protective clothing in the plastic bag and to turn his film badge and dosimeter in at the issue point.

The protective clothing is monitored and sent to an outside laundry which is licensed by the Atomic Energy Commission to handle radioactive material. All clothing is laundered after use even though in most there is not enough contamination present to be detected.

Any components that are removed from the contaminated area are wrapped in plastic before removel to prevent the spread of contamination. They are then taken to the decontamination facility and decontaminated before any further work is done on them. This is usually done by washing. If it is necessary to perform work on a component before it is decontaminated, a clean area is established around the area in which the work is to be done. Inside the clean area protective clothing, film badges, and dosimeters are required.

All water used for decontamination must be filtered until it is at a safe drinking level as far as radioactivity is concerned before it is dumped into the river.

Other areas in which radioactivity is involved are areas in which industrial radiography is done. These areas are handled in a manner very similar to that used in radioactive areas caused by reactors. The areas are roped off and signs are posted indicating radioactive material.

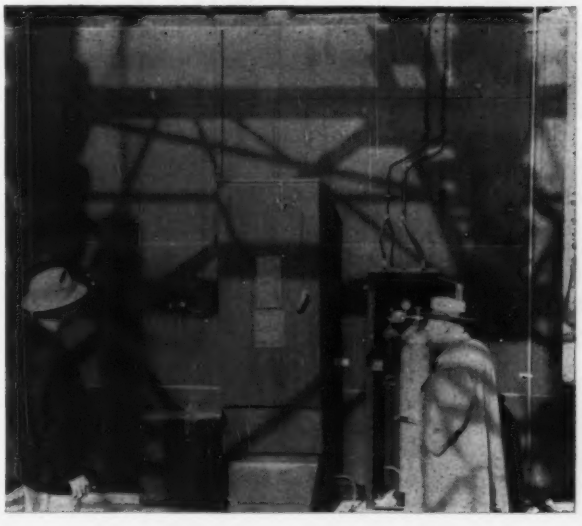
Electric Boat Division has developed its health physics function and facilities as a practical solution to problems resulting from its pioneer work with nuclear power plants. In the nuclear field, as has been true in so many other fields, it is impossible in most cases to state a procedure for doing a job and say that this is the best procedure. As we gain experience, we consistently find better and more practical methods and procedures. The knowledge gained through experience must be documented and made available to others as needed, in order for our country to stay ahead in the nuclear field. In order to facilitate the dissemination of information, Electric Boat has recently organized a radiological guidance group. This group is made up of members from radiation analysis group, operations department, and health physics. The purpose of the group is to promote the effective accomplishment of work in radioactive areas with less human exposure to ionizing radiation. This will be done by organizing and conducting education programs, advising on procedures for accomplishing work in radioactive areas, and by documenting the experience gained by each job.

Sound Absorbing Panels

By use of sound absorbing panels, the Westinghouse Electric Corporation obtained a reduction of noise level for the Utah Power and Light Company's 100,000-kva power transformer. The transformer is located at their McClelland substation in Salt Lake City, Utah.

A noise reduction was accomplished at the Westinghouse transformer division in Sharon, Pa., by using thin metal panels mounted on rubber blocks on four sides of the transformer. Sound absorbing material was placed between the outside panels and the main tank. The sound absorbing material is held in position by clips which are fastened to the main tank wall. The unit tested 54.8 decibels at the factory.

One of the main advantages of supplying sound absorbing panels to the transformer vertical wall area is that a reduction of 6 to 10 decibels can be realized at a relatively low cost, and it does not require any additional floor space.

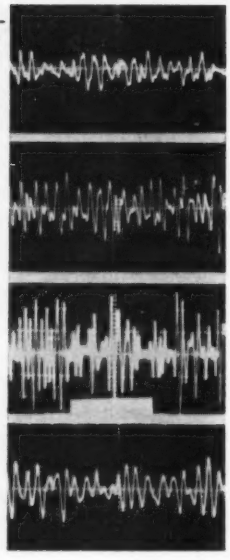


Instrumentation for Coronary-Artery Disease

D. F. MOYER
MEMBER AIEE

G. D. TALBOTT

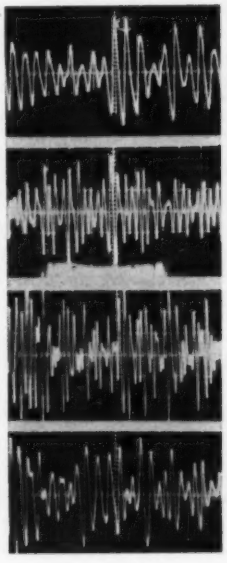
BAND PASS FILTER (cps)	SWEEP SPEED (ms/div)	AMPLITUDE (mv/div)
1200 – 2500	2	50
600 – 1200	5	100
300 – 600	10	200
150 – 300	10	500



◄ Fig. 1. Oscillograms of normal cadaverous heart.

► Fig. 2. Oscillograms of sclerotic cadaverous heart.

BAND PASS FILTER (cps)	SWEEP SPEED (ms/div)	AMPLITUDE (mv/div)
1200 – 2500	2	100
600 – 1200	5	500
300 – 600	10	500
150 – 300	10	500



DETECTION of coronary-artery disease has long been a serious medical problem. A well-known manifestation of this disease is a "heart attack," in which an artery supplying blood to the heart-muscle is suddenly occluded. The severity of the attack depends upon the extent and rapidity of the disruption of blood supply; but all too often, this first indication of coronary-artery disease terminates rapidly in death.

As coronary-artery disease progresses, there is a deposit built up inside the artery. This deposit is called a plaque, and, at least in the initial stages, merely restricts the blood-flow without cutting it off. The deposition of plaques on the interior wall of the artery is uneven, and occurs in discrete segments, usually with longitudinal extension, giving rise to a unique sound generation.

Instrumentation to record and analyze the sound produced in coronary arteries has been developed. To isolate the signal desired, cadaverous hearts were perfused with a saline solution, simulating the coronary flow in an active heart. The sound generated was picked up from the surface of the heart with a magnetic microphone and recorded on a magnetic tape loop. These tape loops were then analyzed by observing the sound spectrum on an octave basis through a bandpass filter. The resultant waveforms observed on an oscilloscope are shown in Figs. 1 and 2. Fig. 1 shows oscillograms of the octave analysis of a cadaverous heart having minimal sclerosis. Another cadaverous heart having advanced coronary-artery disease is illustrated by the oscillograms shown in Fig. 2. The normal heart in Fig. 1 shows a steady decrease in sound amplitude as the higher frequencies are measured. The diseased heart, however, shows little amplitude reduction until the analysis is carried above 1,000 cps. In the sclerotic heart spectrum of Fig. 2, there is evidence of an amplitude modulation in all oscillograms, while the nonsclerotic heart oscillograms shown in Fig. 1 have pronounced pulsing only in the 300- to 600-cps bandpass filter setting. Note the pronounced single frequency component shown by the uniform spacing of the peaks on the time scale. The pulse is often evident by a regular increase or decrease in peaks as shown between 3 and 4 divisions on the third oscillogram of Fig. 2.

In the testing of human subjects, a triggering system was evolved, whereby the oscilloscope sweep would begin just after the second heart sound of a normally-beating heart. By this means it was possible to analyze the sounds of coronary blood-flow during diastole (the period between ventricular contractions). The oscillograms obtained in this manner from patients with a history of coronary-artery disease show evidence of an amplitude modulation similar to those of the sclerotic cadaverous hearts.

Digest of paper 60-100, "Instrumentation for the Diagnosis of Coronary-Artery Disease," recommended by the AIEE Electrical Techniques in Medicine and Biology Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Jan. 31-Feb. 5, 1960. Scheduled for publication in AIEE *Communication and Electronics*, 1960.

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Factors Controlling Generator Shutdowns in Light-Load Periods

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The method employed to determine the economic combination of generating units on the system of New York's Consolidated Edison Company is described.

THE ECONOMIC DISPATCH of generation to minimize system production costs has been under intensive study by the industry for more than two decades. During this period, fundamental theory was developed and the application of the theory was extended to permit the inclusion of refinements.[1]

Briefly, economic dispatch of generation involves the allocation of generation to multiple sources of supply so that each source is at a level of generation for which the incremental unit cost is at the same value. Initially, incremental unit costs were related to power delivered at the bus. Modification for the effect of transmission line losses required tedious and laborious computations involving the solution of simultaneous linear equations equal in number to the number of power sources. The development of electronic economic dispatch computers has facilitated the economic dispatch of generation, and these have been installed where economically justified. The number of installations is increasing rapidly to the point of adoption as standard equipment necessary for effective load dispatching.

The economic dispatch of generation, to be effective, requires the solution of two problems:

1. Selection of the economic combination of generating units for service, consistent with the requirements for spinning reserve capacity.
2. Economic allocation of generation to the units selected.

Although much has been written on the economic dispatch of generation, very little of the literature relates to the selection of the economic combination of generating units. The recent appearance of two papers[2,3] on this subject indicates revival of interest and recognition of its importance.

It is the object of this article to describe the method employed to determine the economic combination of units for service on the Consolidated Edison system. Since physical and operating conditions limit the extent to which production costs can be minimized, particularly during periods of light load, a discussion of these limitations is included, in the hope that this will be of general interest, if not of specific interest, to the reader.

Essentially full text of conference paper 60-847, presented at the AIEE Summer General Meeting, Atlantic City, N. J., June 19-24, 1960, at a session sponsored by the AIEE System Engineering and Power Generation Committees.

H. C. Otten, M. Salvage, and M. J. Steinberg are with the Consolidated Edison Company of New York, Inc., New York, N. Y.

THE LOADING SLIDE RULE

ECONOMIC DISPATCH of generation on the Consolidated Edison system is effected by means of a loading slide rule. It consists of a frame whose dimensions are 17 by 14 inches with slots to accommodate paper strips. Each strip indicates incremental unit fuel costs, loads, and hourly fuel costs. An enlarged section of a sample strip is shown in Fig. 1. Of a total of 80 turbine–generators, only 6 are supplied with single isolated boilers. The remaining turbine–generators are supplied with steam from multiple boilers through common steam headers. For such installations, the strip data must be prepared for each station as a unit, giving rise to numerous combinations of boilers and turbine–generators. With combinations limited to only those likely to be operated, the total number of strips on hand for use by load-dispatching personnel numbers about 1,200, with the maximum number for any one station at 200.

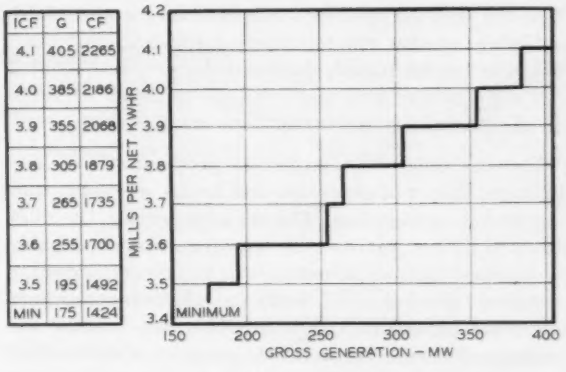

Fig. 1. Enlarged section of generating station strip.

ICF—Incremental unit fuel cost, mills per net kwhr
G—Gross generation, megawatts
CF—Fuel cost per hour, dollars

All strips are of equal length, with indicated incremental unit fuel costs aligned horizontally at equal values. With the use of a straight edge, positioned ver-

tically at any incremental unit cost, the generation allocated to each station is obtained from the station strips. By trial and error, the straight edge is positioned so that the sum of the loads generated at each station matches the system generation requirement. With a little experience, this can be determined in a matter of 2 or 3 minutes.

Generators are scheduled into service or out of service to provide the required spinning reserve capacity throughout the wide range of load demand encountered each day. A sequence for placing units in service and for their shutdown is established on the basis of relative fuel-cost efficiencies. Additions above the minimum number of units that would satisfy spinning reserve requirements must be justified by hourly cost savings. In general, this involves the balancing of the hourly savings in spinning capacity costs avoided by shutting down units during a period of light load against the unit start-up costs. Dividing the start-up costs by the hourly savings defines the number of hours of shutdown needed to break even. It then becomes a matter of judgment whether the calculated duration of required shutdown will prevail to justify the unit shutdown.

Since the strips include hourly fuel costs, the loading slide rule is used to determine system differential costs due to a change in the combination of units in service. Data on start-up costs for each unit in the system are available, so that the selection of the economic combination can be readily determined.

THEORETICAL VS. ACTUAL OPERATION

Factors other than savings in production cost may limit the extent of generator shutdowns, especially during periods of light load. During such periods, the shutdown of all but the most efficient units would probably be justified for most systems in the interest of operating economy. However, such factors as physical conditions, operating problems, and intangibles may restrict the savings which are theoretically possible. Table I illustrates this situation. During the 6-hour period from 12 midnight to 6 a.m. on the typical day selected, it would theoretically have been possible to operate the system with 10 to 14 units less than were actually operated, with corresponding capacity reductions of 810 to 915 mw. The reasons for this large variation between theoretical and actual operations are discussed below.

Table I. Comparison of Actual with Theoretically Economic Operation—September 11, 1959

Time	Gross Generation, mw	Actual Operation		Theoretical Economy Operation	
		Capacity, mw	Number of Units	Capacity, mw	Number of Units
12 midnight	2,025	3,172	32	2,257	18
1 a.m.	1,778	2,889	29	1,983	16
2 a.m.	1,576	2,815	27	1,983	16
3 a.m.	1,436	2,793	26	1,983	16
4 a.m.	1,399	2,793	26	1,983	16
5 a.m.	1,403	2,793	26	1,983	16
6 a.m.	1,531	2,853	27	1,983	16

REACTIVE POWER SUPPLY

One of the major factors in the need for operating more turbine-generators during the daily minimum load period than would be required for most economy operation, is the necessity to absorb excess leading vars by underexciting the generators. At the present time, there are in operation on the system a total of approximately 269 circuit miles of 138-kv, 69-kv, and 45-kv cable. The total charging mvar for this cable system varies from about 690 mvar during the nighttime off-peak load period to about 840 mvar during the daytime when the transmission system must operate at a somewhat higher voltage level than during the period of minimum system load. With growth of the system load, the 138-kv underground transmission system is being extended so that the total charging mvar is increasing from year to year. During the high-load periods of the day, the total system requirements for lagging mvar varies according to seasonal characteristics of the customers' load. Representative figures for the 60-cycle system are 1,515 mvar and 3,365 mw during a typical winter weekday and 1,965 mvar and 3,815 mw on a hot and humid summer day when the air-conditioning load is at a high level.

There are in use approximately 205 mvar of switchable capacitors which add their effect to the charging mvar of the cable system to supply a considerable part of the daytime requirement for lagging vars. As the demand for lagging vars diminishes, the switchable capacitors are cut out. However, the charging vars of the cable system remain, since the policy is to keep in service all transmission circuits at all times except when individual feeders are removed from service for maintenance or repairs.

The duty of absorbing excess leading vars during the light-load period is assigned to the generators in operation. The largest and most efficient units, which are kept in service continuously, perform the major part of this duty. This is particularly true of those units equipped with fast-response excitation systems which permit the generator to be operated at lower levels of excitation with good assurance of remaining stable if the unit picks up megawatt load suddenly in response to governor operation.

A considerable part of the duty for absorbing excess leading vars must be assigned to many of the older units having manually controlled excitation. It is necessary to operate a sufficient number of these units during the light-load period with moderate underexcitation at values to keep the units in the stable range. Sixty-cycle units ranging in size from 22 mw to 160 mw are in this class.

These older units vary considerably in their capability for absorbing excess leading vars from the transmission system. Fig. 2 shows the comparative characteristics of two 160-mw cross-compound units of different manufacture installed in the same station. It will be

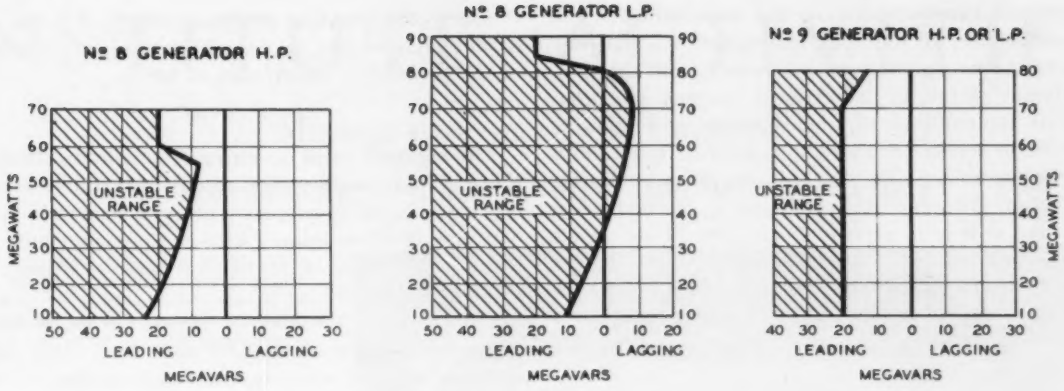

Fig. 2. Stability limits of selected generators with manually controlled excitation.

seen from the stability limit curves for the unit identified as number 8 that only the generator associated with the high pressure turbine of this unit has significant capability of absorbing leading vars. On the other hand, each of the generators associated with unit number 9 can absorb 20 mvar over a wide range of load from minimum to almost full rated load.

Fig. 3 shows the desirable characteristic of a generator associated with one of the newest cross-compound reheat units, which would be selected to operate continuously during the entire daily load cycle. Both generators of this unit are provided with fast-response excitation and have nearly identical characteristics, as shown in this figure. During the minimum daily system load period, units of this kind can safely be operated underexcited, even though they are at such periods operated below their full megawatt capability and are then also assigned the duty of regulating tie-line load and frequency. When economically justified, more of the high-efficiency units will be equipped for fast-response excitation to meet the requirements brought about by the expansion of the high-voltage cable system and to permit more of the older units to be shut down during light-load periods as determined by fuel economy considerations.

PHYSICAL LIMITATIONS

Other factors require operation of turbine–generators during light load periods when fuel economy considerations indicate they should be shut down.

Some examples are:

1. At one station, the 13-kv busses must be operated as two separate sections because of transmission and distribution system requirements and each bus must have a minimum of one generator connected to it. One of these busses supplies a large low-voltage network area and requires a dependable grounded neutral connection which, at this time, can be derived only from a generator. Ultimately, the installation of a grounding transformer will eliminate the necessity of operating a generator to provide the neutral ground.

2. Segregated operation of a 22-mw or 35-mw 25-cycle unit, at a minimum load of 6 mw for single-phase railroad service.

3. Operation of a 35-mw 25-cycle unit at another station where single-phase traction load is superimposed directly upon a 3-phase system supplying synchronous converters. The generator serves to "back up" a 40-mw frequency changer in furnishing phase-converter action necessary to prevent the single-phase load swings from disturbing normal commutation in the synchronous converters.

4. Occasional operation of a condensing unit not otherwise required during light-load periods, for deaeration of make-up feed water in a station supplying steam to a street distribution system.

SAFETY OF OPERATION

The shutdown of generating units may be dictated by reasons other than economy. This is particularly the case when the number of units in service in relation to the level of system generation is such that one or more of the units would have to be operated at loads below safe minimum values. In such a situation, the shutdown of units would be effected without regard to economy.

The safe minimum operating load for modern high pressure–high temperature units is in the range of 20% to 40% of maximum capability. This limit is dependent on the ability to maintain flame stability in the boiler furnace, a requirement which is more imperative when pulverized coal is burned. Flame stability is maintained when the ignition of the mixture of pulverized coal and primary air takes place at a prescribed distance from the burner tips. It is essential to this condition that the velocity of the mixture leaving the burners be greater than the velocity of the flame propagation. If there is a reversal in the magnitude of the relative velocities, the flame will travel upstream toward the burner tips causing puff and flame pulsation. Flashback will occur and combustion may take place inside the burners or in the supply piping, with disastrous results.

For good flame propagation, it is important that the ratio of primary air to fuel be maintained at a relatively constant value. As the load is removed from the unit, regulation of the air-to-fuel ratio becomes somewhat difficult. Some relief is afforded by reducing the number of mills in service, so that the remaining active mills may be operated at rates that will provide more flexible regulation. The limiting condition is reached when only one mill is in service. Regulation of the single mill and of the air-to-fuel ratio may become so unstable that loss of ignition will result. If this happens and reignition occurs before the furnace is adequately purged, the boiler is exposed to a possible explosion and material damage.

If loss of ignition occurs, the turbine may be subjected to thermal stresses in excess of the elastic limit of the turbine metals. Tests and observations have demonstrated that if the rate of steam temperature change exceeds 500 F per hour, the elastic limit will be exceeded. With the loss of ignition, the boiler will, nevertheless, continue to supply steam to the turbine at a rapidly decreasing pressure. The steam will be generated by the flashing of the water in the boiler water walls and drum, with temperatures at saturation. The steam is superheated by flow of stored heat in superheater tubes, steam piping, throttle valve, turbine steam chest, etc. The amount of stored heat is small, but the steam flow to the turbine remains relatively large, so that the resulting rapid heat transfer from metals to steam produces a rapid drop in the temperatures of the metal surfaces swept by the steam. The rate of temperature reduction has been observed to be from 25 to 50 F per minute, corresponding to hourly rates of 1,500 and 3,000 F, respectively, which would be greatly in excess of the permissible hourly rate of 500 F.

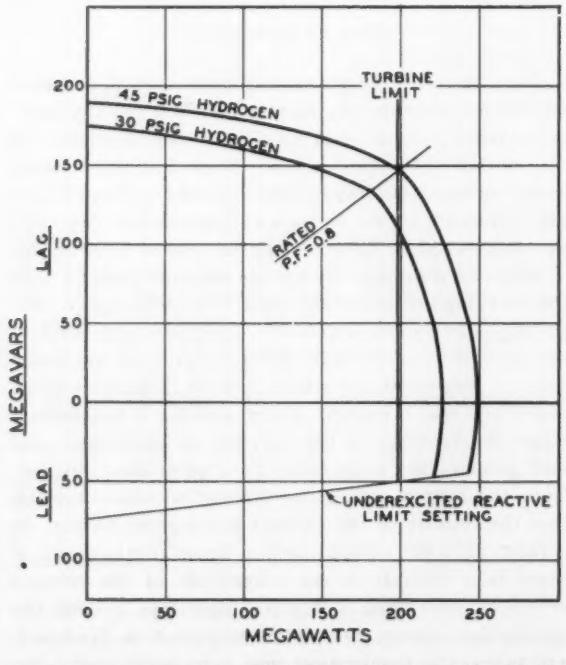

Fig. 3. Generator capability. Typical generator for one turbine of 365-mw cross-compound reheat unit having fast-response excitation.

QUICK STARTS

THE REALIZATION of operating economies by the shutdown of high pressure–high temperature units has been facilitated by the development of quick start techniques. Start-ups of Consolidated Edison Company units are made in a matter of 15 to 20 minutes following an overnight shutdown.

There is some hesitancy on the part of many operators to shut down and restart units on a daily basis. This is understandable when it is realized that the most critical periods in the life of a unit are during starting and, to lesser extent, during shutdown. However, the exposure to damage should not be magnified to the point where it limits reasonable economic practice.

The Consolidated Edison Company and others, as well as the turbine manufacturers, have made exhaustive quick start-up tests which have been described in several papers.[3-8] These indicate that with proper precautions and equipment, units can be shut down and restarted daily without exposing them beyond the margins of safety incorporated in their design.

LABOR SAVINGS

THE DAILY SHUTDOWN of specific units on the Consolidated Edison system has resulted in substantial savings in operating labor. It has been possible to reduce personnel for the midnight watch and in some cases completely eliminate supervision in certain sections of a plant. This has resulted in 2-watch operation and has made necessary the timing of watches from 7 a.m. to 3 p.m., and from 3 p.m. to 11 p.m. In some instances, where less efficient units are located, complete shutdown of plant sections has been possible over week ends from 11 p.m. Friday to 7 a.m. Monday.

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INSTITUTE ACTIVITIES

Message to Posterity Is Enclosed in Cornerstone of New United Engineering Center

THE text of an address by former President Herbert Hoover to posterity was enclosed in the cornerstone vault of the new $12 million United Engineering Center in New York on the afternoon of June 16 at the setting of the cornerstone.

Mayor Robert Wagner, who delivered the principal address at the ceremony, said that New York is "proud and fortunate to be known as the country's center of engineering activities."

About 450 persons were present when the cornerstone was laid for the 20-story structure of steel and glass between 47th and 48th Streets at United Nations Plaza.

Many Changes Are Forecast

In his message, Mr. Hoover, who is an honorary member of the AIEE, predicted that when the cornerstone receptacle is opened 100 years hence, scientific discovery and invention will have produced many changes in life. He anticipated that during the next century new economic and social changes will have been imposed and that changes will have occurred in the methods of government.

Mr. Hoover noted that the world's progress in the last century came from "free and productive minds in the civilized part of the world."

He lauded the engineering profession whose training "demands intellectual integrity and minds to whom truth has become an instinct."

In closing, Mr. Hoover spoke of communism as a major danger to civilization, and bid his successors to keep alive the stabilizing forces of religion and "the unextinguishable spark in man to be free."

Andrew Fletcher, president of United Engineering Trustees, Inc. (UET), which owns and operates the United Engineering Center, presided at the cornerstone laying ceremonies. W. F. Thompson, chairman of the Real Estate Committee and UET vice-president, commented on the cornerstone and its contents.

After the setting of the cornerstone, the benediction was given by the Rev. R. H. Rosché, pastor of the Presbyterian Church of the Covenant, New York.

On its completion in mid-1961, the structure will become the headquarters for 18 American engineering societies which represent more than 250,000 members.

The United Engineering Center is being financed by voluntary contributions from individual engineers and companies concerned with engineering. Many of the groups scheduled to move into the new building, including the world's largest engineering library, are now housed at the 50-year-old Engineering Societies Building, 29 W. 39th St., New York.

CORNERSTONE for the new $12 million United Engineering Center in Manhattan was laid June 16, with Andrew Fletcher (*left*), president of the United Engineering Trustees, Inc., presiding, and former President Herbert Hoover (*center*) and Mayor Robert Wagner (*right*) assisting at the ceremony.

"A Message for Posterity"

Mr. Hoover's message, entitled "A Message for Posterity," follows:

"I have been asked to contribute a forecast of what this world may be like when this receptacle is opened one hundred years hence.

"It happens that mortals have seldom been equipped with the gift of prophecy. And the past records of prophets are not too reassuring on the reliability of 'run-of-the-mine' members of that profession!

"In any event, one can only appraise the forces in motion today and speculate on their effect on the next century.

"We can say with assurance that the progress of the world in the last hundred years has come from free and productive minds in the civilized part of the world—that is, the nations possessed of independence and personal freedom. If these freedoms be preserved, they will bring more and more discoveries into the fundamental forces in the Universe. And then the engineers will apply these discoveries to the release from less important tasks and bring more comforts to mankind.

"Even the problem of adequate food supply to a world faced with increasing numbers may yield to scientific discovery and invention. A century ago 80% of our population was employed on farms producing food and raw textiles while today, thanks to advances in science and engineering, less than 20% of our population is required for this duty. Perhaps our methods which have produced such a result will spread in nations yet primitive in their food production.

"During the last century our profession of engineering has advanced from the status of a trade to a great profession ranking with all other great professions. And with the training required for an engineer a great contribution for the future has come to the world. The very nature of training for our profession demands intellectual integrity and minds to whom truth has become an instinct. The leaven of this sort of mind will contribute to continuing progress in the free world.

"We can be sure that scientific

LISTENING attentively as former President Herbert Hoover read his message at the setting of the cornerstone for the United Engineering Center were: *(left to right, front row)* Commissioner W. C. Patterson, New York City Department of Commerce and Public Events; A. P. Sloan, honorary chairman, Industrial Gifts Campaign; Andrew Fletcher, president, United Engineering Trustees; Mayor Robert Wagner of New York City; W. F. Thompson, chairman, Real Estate Committee; and H. C. Turner, Jr., president, Turner Construction Company; *(second row)* D. V. Terrell, Board of Trustees member; J. L. Gillson, president, American Institute of Mining, Metallurgical, and Petroleum Engineers; Frank Marston, president, American Society of Civil Engineers; A. M. Gaudin, chairman, Engineering Foundation; S. D. Kirkpatrick, American Institute of Chemical Engineers; and Beatrice Hicks, Society of Women Engineers; *(third row)* G. T. McCarthy, vice-president, American Institute of Consulting Engineers; J. B. Browder, president, Illuminating Engineering Society; C. I. McGuffie, American Welding Society; P. J. O'Leary, president, Municipal Engineers of the City of New York; and W. L. Betts, chairman, Engineering Societies Library Board.

discovery and invention will produce many changes in life, will impose new economic and social changes, and will necessitate changes in the methods of government in this next century.

"But civilization is faced with a major danger. At least 600 million people have adopted Communism which denies religious faith, which finds its inspiration in rank materialism and whose primary tenet is that, by conspiracy or military action, freedom will be extinguished in the world.

"Within all the problems of the free governments and of international life there are stabilizing forces. Religious faith, its inspiration to moral virtues, and the unextinguishable spark in man to be free may well be the salvation of progress and civilization. We can at least bid our successors to make sure these forces live."

(signed) *Herbert Hoover*

The Waldorf Astoria Towers
New York, N. Y.

Mayor Wagner's Address

Mayor Wagner's remarks follow:

"The cornerstone and the keystone are the familiar emblems, or the benchmark, if you will, of the professional engineer in the design of buildings and bridges.

"We have learned to place our faith in the cornerstone as well as in the keystone in recognition of the dedication that engineers have offered to our progress and to our very way of life. Indeed, without engineers to regulate our rapid pace of modern times, we would have chaos.

"We have come to solemnize rather than to celebrate the placing of a cornerstone, even though it be a joyous occasion, because traditionally the cornerstone signifies strength and character and customarily carries the date of the birth of the building.

"Today we commemorate the goal sought by 18 engineering Societies, five of which were the prime movers in an ambitious project to provide comfortable and attractive quarters for the 18 groups which will maintain offices here.

"Our tribute is not to a building because it will enhance the skyline of our City but because it will accommodate a class of professionally trained men and women who are dedicated with a common, unselfish interest; the benefit of their fellow man.

"To them, in a large measure, we owe our day-to-day safety and the many comforts and conveniences that, as New Yorkers, we are likely to take for granted.

"In dedicating this cornerstone today we can contemplate the power, the integrity and the precision which dictates the determination of professionally trained engineers and we can afford to feel confident that our best interests are their primary concern.

New York City Is Proud

"We are grateful, too, for the fact that when the United Engineering Trustees agreed that their 50-year-old quarters could not be enlarged, they nevertheless elected to remain here in New York City and build anew. Our City is proud and fortunate to be known as the country's center of engineering activities.

"Our own city administration, I am proud to say, played a part in the events leading up to this happy occasion of today, for in April 1955, when other cities were importuning the Societies to leave New York, at my instruction the Department of Commerce held a luncheon meeting of leading engineers and industrialists, members of your Societies. As a result of that meeting, a committee was formed which surveyed the facilities offered by the competing cities and then recommended that the Societies remain in New York. In this decision, the views of President Hoover carried great weight for he wrote at the time that New York was the only city in which the engineers could find a proper intellectual climate. Commerce and other city agencies also assisted in finding the site—the present one—for the Societies and in preparing the way for construction.

"Industry and education, as well as engineers, have contributed toward the United Engineering Center and we may be certain that the seed of truth thus spread will take root and produce a hundredfold, thus bringing benefit to industry, advancement to education and gratification to individual engineers as well as their respective Societies.

"If I am not mistaken, I understand that it was largely upon the initiative of industry but certainly it was upon the pledges of some 500 industries, that the bold step was taken in this instance toward the summit of success in the mutual appreciation of engineers and industry.

"It is reassuring to know that industry nowadays assumes its moral obligation to education and culture, and therefore to mankind.

AIEE Future Meetings

Pacific General Meeting*
El Cortez Hotel
San Diego, Calif.
August 8-12, 1960

Aero-Space Transportation Conference*
El Cortez Hotel
San Diego, Calif.
August 8-12, 1960

AIEE-AIChE-IRE-ISA-ASME Joint Automatic Control Conference*
Kresge Auditorium
Massachusetts Institute of Technology
Cambridge, Mass.
Sept. 6-9, 1960

AIEE-ASME Engineering Management Conference*
Morrison Hotel
Chicago, Ill.
September 14-16, 1960

AIEE-IRE Industrial Electronics Symposium*
Manger Hotel
Cleveland, Ohio
September 21-22, 1960

AIEE-ASME National Power Conference*
Bellevue-Stratford Hotel
Philadelphia, Pa.
September 21-23, 1960

Petroleum Industry Conference*
Skirvin Hotel
Oklahoma City, Okla.
September 25-28, 1960

Fall General Meeting
Morrison Hotel
Chicago, Ill.
October 9-14, 1960
(Final date for †TP—closed, ‡CP Syn.—closed, CPMs—Aug. 5)

AIEE-IRE-SMPTE National Electronics Conference
Sherman Hotel
Chicago, Ill.
October 10-12, 1960
(Final date for †TP—closed, ‡CP Syn.—closed, CPMs—Aug. 5)

Nonlinear Magnetics and Magnetic Amplifier Conference*
Bellevue-Stratford Hotel
Philadelphia, Pa.
October 26-28, 1960

AIEE-IRE-ISA Electrical Techniques in Medicine and Biology Conference
Sheraton Park Hotel
Washington, D. C.
October 31—November 2, 1960
(Final date for †TP—Aug. 2, ‡CP Syn.—Aug. 17, CPMs—Aug. 26)

Power Industry Computer Application Conference
Chase Hotel
St. Louis, Mo.
November 9-11, 1960
(Final date for †TP—Aug. 11, ‡CP Syn.—Aug. 26, CPMs—Sept. 5)

Fall Textile Conference
Sir Walter Hotel
Raleigh, N. C.
November 10-11, 1960
(Final date for †TP—Aug. 12, ‡CP Syn.—Aug. 26, CPMs—Sept. 6)

AIEE-AIP Magnetism and Magnetic Materials Conference
Hotel New Yorker
New York, N. Y.
November 14-17, 1960
(Final date for †TP—Aug. 16, ‡CP Syn.—Aug. 31, CPMs—Sept. 9)

AIEE-NEMA Electrical Insulation Conference
Conrad Hilton Hotel
Chicago, Ill.
December 5-8, 1960
(Final date for †TP—Sept. 6, ‡CP Syn.—Sept. 21, CPMs—Sept. 30)

AIEE-IRE-ACM Eastern Joint Computer Conference
Hotel New Yorker
New York, N. Y.
December 11-14, 1960
(Final date for †TP—Sept. 12, ‡CP Syn.—Sept. 27, CPMs—Oct. 7)

AIEE-IRE-ASQC Reliability & Quality Control Conference
Bellevue-Stratford Hotel
January 9-11, 1961
(Final date for †TP—Oct. 11, ‡CP Syn.—Oct. 25, CPMs—Nov. 4)

Winter General Meeting
Hotel Statler
New York, N. Y.
January 29-February 3, 1961
(Final date for †TP—Oct. 31, ‡CP Syn.—Nov. 10, CPMs—Nov. 25)

AIEE-IRE-U of P International Solid-State Circuits Conference
Philadelphia, Pa.
February 15-17, 1961
(Final date for †TP—Nov. 17, ‡CP Syn.—Dec. 2, CPMs—Dec. 12)

South East District Meeting
Jung Hotel
New Orleans, La.
April 5-7, 1961
(Final date for †TP—Jan. 5, CPMs—Jan. 30)

Materials Handling Conference
Chicago, Ill.
April 11-12, 1961
(Final date for †TP—Jan. 11, ‡CP Syn.—Jan. 26, CPMs—Feb. 6)

Cement Industry Conference
Sheraton-Cadillac Hotel
Detroit, Mich.
April 18-20, 1961
(Final date for †TP—Jan. 18, ‡CP Syn.—Feb. 2, CPMs—Feb. 13)

Great Lakes District Meeting
Hotel Pick-Nicolett
Minneapolis, Minn.
April 19-21, 1961
(Final date for †TP—Jan. 19, CPMs—Feb. 13)

Rural Electrification Conference
Kentucky Hotel
Louisville, Ky.
May 1-2, 1961
(Final date for †TP—Jan. 31, ‡CP Syn.—Feb. 15, CPMs—Feb. 24)

AIEE-IRE-ACM Western Joint Computer Conference
Ambassador Hotel
Los Angeles, Calif.
May 9-11, 1961
(Final date for †TP—Feb. 8, ‡CP Syn.—Feb. 23, CPMs—Mar. 6)

North Eastern District Meeting
Statler Hotel
Hartford, Conn.
May 17-19, 1961
(Final date for †TP—Feb. 16, CPMs—Mar. 13)

Fractional Horsepower Motors Conference
Biltmore Hotel
Dayton, Ohio
May 23, 1961
(Final date for †TP—Feb. 22, ‡CP Syn.—Mar. 9, CPMs—Mar. 20)

Summer General Meeting
Cornell University
Ithaca, N. Y.
June 18-23, 1961
(Final date for †TP—May 20, ‡CP Syn.—May 30, CPMs—Apr. 14)

Pacific General Meeting
Hotel Utah
Salt Lake City, Utah
August 23-25, 1961
(Final date for †TP—May 25, ‡CP Syn.—June 5, CPMs—June 19)

*Final date for submitting papers—closed

†TP—Transactions Paper
‡CP Syn.—Conference Synopsis
CPMs—Conference Manuscript
DPMs—District Manuscript
(District Paper Synopses should be directed to the District Meeting Committee)

Transactions and conference papers must conform to the requirements in *Author's Guide*
For a copy, write to E. C. Day, AIEE, 33 W. 39th St., New York 18, N. Y.

"The profession of law and government which I chose to follow, as my father before me, is older than that of engineering and I am acutely aware of the fact that the stature and prestige of the professional engineer has become firmly entrenched during the lifetime of most of us. Patterned more or less upon the principles which for centuries have applied to law and to medicine, the practice of engineering is founded upon self-imposed standards, is monitored by Societies such as those which have combined to create this Building as a reality, and is certified by legislative and educational requirements.

"The stature and prestige of professional engineering must be preserved and advanced in no lesser degree of perseverance than in law or in medicine. No longer is the engineer regarded as a man of war but, rather, he has become one of us in the older professions and among us a force for the good of his community and our society as a whole.

City Engineers To Share Benefits

"It is particularly gratifying to me to know that the Municipal Engineers of the City of New York is one of the Societies that will take advantage of these completed facilities; that they have contributed toward this citadel and will share in its benefits.

"It is this group in Civil Service that forms the nucleus among leaders in design, supervision and construction that bring to New York City some of its best known but perhaps least-publicized facets as a city of marvels; again in the category of services that we find are taken for granted.

"Without detracting from those in private engineering practice, many of whom we value highly as consultants, I must say that our municipal engineers are indeed a loyal core of industrious, conscientious and cost-conscious professionals who have an abiding pride in their City—our City —and in our many urban communities.

"From the viewpoint of a native New Yorker rather than as Mayor, I feel privileged to take part in this ceremony which is in the nature of launching an imposing, impressive and inspiring program which will inure to the equal benefit of engineering as a profession and to New York City as a center of training and experience, of education and employment.

"It is my hope that engineering will continue to preserve New York City as the marvel of the New World and that in cementing this symbolic stone we will have strengthened not only the foundation of a highly significant professional building but our healthy and dynamic society in which we have implicit confidence to surmount trouble and survive threat, not only during our times but beyond the distant future."

W. E. Hawkins

HONORARY membership in the AIEE was bestowed upon E. B. Robertson *(center)*, a past-president of the AIEE. The honorary membership certificate was presented by AIEE President J. H. Foote *(right)* to Mr. Robertson at the general session of the Summer General Meeting. Looking on is A. C. Monteith *(left)*, past-president, who delivered the Citation of the Recipient.

Engineers Assemble in Atlantic City for Institute's Summer General Meeting

ATLANTIC CITY, N. J., one of the nation's foremost seaside resorts, was the locale for the 1960 AIEE Summer General Meeting. The Chalfonte-Haddon Hall Hotel served as headquarters for the gathering which took place June 19-24. Approximately 2,000 engineers, their wives, and invited guests attended. There were 197 technical papers presented at 47 sessions.

Among the social events were a cabaret dance in the Vernon Room at the Haddon Hall, a dinner and show on Wednesday evening, and a moonlight cruise along the Atlantic City coast.

Inspection trips were made to the SAGE Direction Center, McGuire Air Force Base, N. J.; Federal Aviation Agency, Bureau of Research and Development, National Aviation Facilities Experimental Center, Atlantic City; and the Eddystone Station, Philadelphia Electric Company, Philadelphia, Pa.

General Session

S. R. Warren, Jr., general chairman of the Summer Meeting, presided. Welcome addresses were made by D. L. Greene, vice-president, District 2; and R. S. Hewitt, chairman, Philadelphia Section.

J. H. Foote, outgoing AIEE president, reported on the results of the ballot on constitution amendments and the election of officers (Tellers' Report). C. H. Linder, as president-elect, heads the list of new officers for the 1960-61 term. The vice presidents are: C. E. Gaylord, R. T. Weil, Jr., F. W. Bush, S. C. Wright, H. A. Carlberg, A. W. Rauth, Walter Criley, and P. G. Wallace. Directors named were: R. B. Gear, C. T. Hatcher, and C. T. Pearce. W. R. Clark was elected to a 1 year term as treasurer.

President-Elect Linder Introduced

At the conclusion of the report, President Foote introduced President-Elect C. H. Linder, who is a vice-president and group leader, Electric Utility Group, General Electric Company.

Mr. Linder spoke of the opportunities that lie ahead for the AIEE. To exploit these opportunities, he said, it is necessary always to bear in mind the three major objectives of the Institute: (1) transmission and exchange of technical information, (2) interest and participation in engineering education, and (3) raising the professional status of its members. The first objective is prime. We are living in a period, he pointed out, in which a rapidly expanding technology is having major social and economic consequences. It is necessary, therefore, that engineers become more alert to the social implications of their work.

The President-Elect then stressed the things that must be done to maintain

the growth and vigor of the Institute. These are: (1) probe barrier problems, (2) continue exchange of information with other societies, and (3) pay constant attention to the internal structure of the Institute so as to keep up with expanding technology and the changing needs of society.

Mr. Linder concluded by recounting the efforts the AIEE is making toward unity of the engineering profession. These efforts are both administrative and technical with the latter taking place mainly through sponsorship and co-sponsorship of Special Technical Conferences which are proving a huge success. This augurs well for unity since contact at this level has the greatest impact.

A certificate of honorary membership in the Institute was presented to E. B. Robertson, past president of AIEE. The presentation was made by J. H. Foote after the "citation of the recipient" was read by A. C. Monteith.

Student Winners

Certificates for technical papers that had won first prize in each of 14 of the 15 districts of the AIEE were presented. Presentation of certificates was made by President Foote and F. W. Smith.

The prize paper winners and titles of their papers are:

Michael Leeming, Bordentown, N. J., "A Dynamic Characteristic Tracer Using a Single-Crystal Barium Titanate Capacitor"; W. F. Chambers, High Rolls, Mountain Park, N. Mex., "A Study of the Properties of Thin-Films of Iron Cobalt at High Temperature"; Augusto Spencer, Santiago, Chile, "Thermoplastic Recording"; R. F. Stanfield, Cheyenne, Wyo., "A Fully Automatic, Variable Programmed Telephone Dialer"; F. H. Cleveland, Bryan, Texas, "Determination of a Mathematical Formula for the Hysteresis Loop and the Computation of the Hysteresis Loss in Magnetic Materials by Numerical Methods"; C. S. Gillmore, Stanford, Calif., "High-Frequency Extraterrestrial Investigations"; R. M. Gardner, Salt Lake City, Utah, "Analog Computer Simulations of Heart Response to Nerve Stimulation"; J. C. Engel, Cincinnati, Ohio, "Induction Motor Performance by Computer"; R. A. Shappy, Providence, R. I., "Information Retrieval—A Scheme for Mechanically Searching Technical Literature"; O. G. Gabbard, Sand Gap, Ky., "A Low-Speed Thyratron Counter-Scaler Unit"; O. A. Kolody and G. A. Praver, Cleveland, Ohio, "Marine Navigation Traffic Control System"; R. T. Modafferi, New York, N. Y., "New Ideas in the Synthesis of Pipe Organ Tones Using Electronic Circuitry"; Alexander Graps, Jr., Washington, D. C., "Signal Flow Graphs."

L. A. Kilgore, director of engineering, Westinghouse Electric Corporation, East Pittsburgh, Pa., received the 1959 Lamme Gold Medal. The history of the Medal was recounted by J. H. Chiles, Jr. J. F. Calvert presented the biography of the medalist. Dr. Kilgore's address and those of the other participants in the Medal presentation are found on pp. 662-65 of this issue.

Technical Sessions

Data Handling and Computer Application in Power Plants. A round-table discussion on this topic dealt with various facets of the problem and need for automating power plants. The utility industry's widespread interest in data-handling and computer equipment is shown by the increasing number of utilities which are purchasing equipment and the number of manufacturers who have entered this field. The majority of the systems being built perform these functions: (1) scanning for off-normal conditions, (2) automatic logging, (3) trend recording, (4) automatic recording data on tape for future use, (5) computing of performance using data gathered by the system, and (6) automatic control using digital computers. Skyrocketing fuel and labor costs have been offset, in part, through the installation of larger and higher pressure turbine-generator units, and through the use of central control rooms and automatic control equipment in some power stations. All panel experts agreed that the use of data-logging and computer equipment is helping to bring into fruition the eventual complete automation of power plants.

Nuclear Safety. A group of papers dealt with the latest methods and procedures used to insure safe working conditions in radioactive work areas. J. E. Standefer, Chance Vought Aircraft, spoke on safety problems relating to nuclear vehicles. These problems arise from the toxicity of nuclear fuel and the toxicity of some fuel element materials; the potentially large and sudden release of energy from nuclear fuel with attendant emission of gamma and neutron radiation; neutron activation of materials within and surrounding the vehicle; and the possible release of fission fragments with resultant emission of gamma radiation and resultant internal dose due to possible inhalation or ingestion of fission fragments. These problems in small or large degree were discussed by all the speakers with emphasis on the special conditions obtaining at their respective industrial sites. It was agreed that effective control of radioactivity has indeed proved feasible even in the testing of nuclear vehicles.

Color Television

Broadcasting. A. E. Bachelett and C. A. Collins of the Bell Telephone Laboratories, Murray Hill, N. J., and E. R. Taylor, Bell Laboratories, Haverhill, Mass., reported on nation-wide spread of color television facilities in their paper "New Television Network Switching Facilities." A very large percentage of the 85,000 channel miles of the country's television facilities are equipped for color transmission, they reported. New equipment has been developed to meet the problem of switching on nation-wide television programs. Back of the ability of the various televsion networks to originate or receive programs almost anywhere in the United States, lies a large web of intercity and local audio and video transmission and switching facilities leased by the Bell System to the television networks. Companion papers dealt with low light level television, design criteria for transistorized television cameras, and sine squared pulses in television system analysis.

Communications Switching. Automation in telephone switching equipment engineering and the development of special positions for handling person-to-person, collect, and credit card calls were some of the topics developed in papers presented at this Wednesday morning session. L. W. Blumer, Northwestern Bell Telephone Company, G. E. Reifenstuhl, Western Electric Company, and N. E. List, Michi-

W. E. Hawkins

STUDENT prize-winners together with AIEE members attending the Summer General Meeting were: *(left to right, standing)* F. H. Cleveland, Bryan, Texas; W. F. Chambers, Mountain Park, N. Mex.; O. A. Kolody, Cleveland, Ohio; R. T. Modafferi, Englewood, N. J.; R. M. Gardner, Salt Lake City, Utah; Augusto Spencer, Santiago, Chile; O. G. Gabbard, Sand Gap, Ky.; C. S. Fillmore, Stanford, Calif.; and Michael Leeming, Bordentown, N. J.; *(seated)* J. C. Engle, Cincinnati, Ohio; R. F. Stanfield, Cheyenne, Wyo.; J. H. Foote, Jackson, Mich., AIEE president; Prof. Smith, chairman of the Student Branches Committee; and R. A. Shappy, Providence, R. I.

gan Bell Telephone Company, noted, in their paper on switching equipment engineering, that the telephone industry is beginning to use computers to engineer new telephone switching equipment and additions to it. Most of this equipment which sets up calls among subscribers is located in central offices. The paper examines the factors involved in manually engineering this equipment which helps explain why the Bell Telephone Company feels computers will make engineering faster, cheaper, and more accurate. Other papers dealt with the "Synthesis of a Resonant Transfer Filter as Applied to a Time Division Multiplex System," and "A Mechanical Presentation of a Transportable Electric Switching System."

Electric Automobile

Chemical Industry. The potentialities of the electric automobile in the light of a number of changes in transportation practices and new technological developments was presented by B. F. Bennett, General Electric Company. There are many widely differing opinions concerning the future of the electric auto. They range from complete rejection of its resurrection to optimistic hopes of large quantity production, the author said. It is doubtful that anyone can accurately predict the ultimate outcome because of the large number of factors which are subject to sudden change—particularly in the area of technical developments. The following are the author's conclusions on the subject: (1) Technically feasible for specialized use—compact auto for short trips; (2) Have significant advantages: low operating and maintenance costs, no exhaust fumes, simple mechanical construction; and (3) Have definite problems: high first cost, excessive battery weight and size, need further improvements in control.

B. Eilbeck, Nife, Inc., presented a paper on nickel cadmium batteries, and H. C. Riggs, Electric Storage Battery Company, spoke on "Electric Vehicles, Battery Power Supplies."

Information Processing and Retrieval. A prediction that the state of the art in information systems techniques and equipments is on the verge of a breakthrough that will eliminate many presently envisioned applications problems was made by A. F. Glimn and R. D. Greenway in their paper "Information Storage and Retrieval Part I—Dogs, Cats, and Indexing." They noted that economic application problems will remain forever, but from the viewpoint of equipment and techniques, it will be perfectly feasible, within a few years, to carry extremely large libraries of information in on-line digital computer storage. Physical storage and handling of books, the authors point out, will rarely occur in such a library. Automatic page readers; automatic information indexing by the computer; cheap, bulk, random access memory; and high-speed electronic printing will all be available in less than 5 years.

Companion papers discussed "Post Office Mechanization," and "Design Considerations for Computer Driven Displays in the FAA Machine Simulator for the Study of Air-Traffic Control Systems.

Jet Age Requirements

Industrial and Commercial Power Systems. The jet age has created a need for new electric power sources at the aprons of airports, J. B. Chapman noted in his paper "The Case for Standardizing Airport Apron-Outlet Distribution Systems at 1,000 Volts, 400 Cycles." Common practice now, he said, is to supply power to energize pumps, compressors, brakes, air conditioning, de-icing equipment and engine starting of parked aircraft from mobile combustion engine-driven generators but the operational advantages of apron-outlets are obvious. Mr. Chapman recommended supplying alternating current at 1,000 volts, 400 cycles from generators in the airport terminal and distributed to outlets on the airport apron at 380 volts, 50 cycles; a motor generator set or rectifier would be adjacent to the parked aircraft to convert to power at the desired frequency. The author pointed out that electrical requirements of aircraft have increased from 3 kw for the DC-3 in 1938 to as much as 140 kva for present-day jets.

D. T. Michael, Cincinnati Gas & Electric Co., read a paper on "Power Company Policies in Serving Industrial Plants," and C. C. Saunders, E. I. Du Pont de Nemours & Co., spoke on "Factors Determining Primary Substation Ownership."

Tracking Resistance

Electrical Insulation. At a Monday morning session sponsored by the Electrical Insulation Committee. A. L. Sommerman, Westinghouse Electric Corporation, presented a paper on electrical tracking resistance of polymers. The investigation described covered a 4-year period and encompassed surface-tracking properties of many types of synthetic polymers, including thermoplastic dielectrics, rigid casting resins and laminates, and rubber encapsulating compounds. Motion pictures in color showing the tracking were shown as part of the presentation.

Also presented was a paper on the effects of electric discharges on solid insulation.

Instrumentation. A single-channel digital data recorder for process monitoring was covered in a paper by W. J. Schmidt and E. A. Sagan, of Westinghouse Electric Corporation. Features of the system include good accuracy, linearity, and response characteristics; ability to develop full output for a wide range of analog input signals; high-speed automatic translation of recorded data; and relatively low cost. The device described is capable of recording any analog quantity ranging from 25 to 400 millivolts full scale.

Design information and performance characteristics of miniaturized current transformers for multirange operation of milliammeters ink recorders were outlined by W. A. Geyger, U. S. Naval Ordnance Laboratory.

A transistorized digital draw-speed indicator has been developed for the paper industry, as reported by W. J. Schmidt and S. Salowe, both of Westinghouse. The instrument provides operating personnel with a means of reproducing accurately section speeds and draws that will produce a desired grade of paper.

Distribution. Two papers by J. A. Smith of General Electric describe studies for the determination of economical substation sizes and primary distribution voltages. In the first paper, some of the principles involved in the selection of substation size are illustrated by comparing costs for new distribution systems installed overnight to serve various load densities under uniform or ideal conditions. Results are obtained by illustrating the effect of different variables on total system cost as conditions are changed. By extending these results an economic comparison is made, in the second paper, of the traditionally used 4.16- and 12.5-kv primary distribution voltages as well as higher volt-

W. E. Hawkins

PARTICIPANTS in the panel discussion on "Exploring the Future of Direct Energy Conversion" were: *(left to right)* I. Wolf, Radio Corporation of America Laboratories; R. W. Pidd, General Dynamics Corporation; L. R. Gaty, Philadelphia Electric Company, and panel chairman; R. W. Porter, General Electric Company; and R. W. Blue, Bendix Aviation Corporation.

ages of 20.8, 23, 24.9, and 34.5 kv. Also considered are all overhead systems for serving predominantly residential-type loads with 120/240-volt single-phase utilization.

The influence of transmission on distribution costs is analyzed in a paper by R. N. Reps and J. E. McNabb, Westinghouse Electric Corporation.

Basic Sciences. A Wednesday morning session sponsored by the Basic Sciences Committe covered a wide variety of topics, including magnetic materials, step responses, transcendental nonlinear systems, saturable reactors, and acceleration spectral density curves.

Space-age applications of Supermendur, an alloy of 2% vanadium, 49% iron, and 49% cobalt, are described in a paper by M. Lauriente and R. E. Lee, Westinghouse Electric Corporation. Among the advantages are low hysteresis loss, low coercive force, high permeability, and high remanence. Also presented is a description of the core design and performance of a transformer using Supermendur.

PINNING the president's badge to President-Elect C. H. Linder *(left)* is J. H. Foote *(right)*, AIEE president for the year 1959-60. Mr. Linder's term of office as AIEE president begins August 1, 1960.

Detecting Faults

Transformers. At a Wednesday afternoon session on transformers, C. W. Miller of Westinghouse presided. An effective and sensitive means for detecting low-energy incipient faults in power transformers having gas space above the insulating oil is now available, as reported in a paper by P. S. Pugh, American Electric Power Service Corporation, and H. H. Wagner, Pennsylvania Transformer Division, McGraw-Edison Company.

Studies of the problem of transformer noise and calculation of its attenuation by means of barrier walls were described in a report by the AIEE Working Group on Technical Investigations of the Audible Sound Subcommittee, AIEE Transformers Committee.

Also described was a bibliography on transformer noise which has been prepared by this Working Group.

Substations. At one of several sessions devoted to substations, the first paper was by J. D. Hoffman, High Voltage Equipment Company, who described how the public relations of several utilities have been improved through the use of attractive enclosures around substations in residential areas.

R. N. Southgate of Public Service Electric & Gas Company discussed the first indoor high-voltage station on his company's system. The 138/26/13-kv switching station, located in the center of Newark, N. J., was placed in service in December 1959 to provide a major reinforcement to the subtransmission supply in this metropolitan area.

Papers were also presented on mobile substations in the San Diego, Calif., area and 161-kv substation design in Omaha, Nebr.

Hydro–Thermal System Operation. Among the interesting papers presented on hydro–thermal systems was one by L. G. Peck of Arthur D. Little, Inc., Cambridge, Mass., discussing dynamic programming techniques as applied to the scheduling of hydroelectric generation.

Recent progress in the field of incremental cost determination for hydroelectric power plants has taken place in Sweden, as reported in a paper by S. Stage and Y. Larsson of the South Sweden Power Company. The results relate chiefly to a combined hydro and thermal system, where hydro power is predominant.

Exploring the Future of Direct Energy Conversion

A panel discussion on this subject was held on Thursday afternoon before a large and enthusiastic audience. L. R. Gaty of the Philadelphia Electric Co. was chairman.

The first speaker was Dr. R. W. Pidd, General Dynamics Corp., who talked about new patterns in power generation in terms of temperature. He described at length the direct production of electricity from the heat of nuclear fission which has been undergoing tests. In brief, the apparatus is a cesium cell constructed with its emitter electrode made of a solid solution of uranium carbide and zirconium carbide. When placed in the Triga reactor, the fissioning of the uranium heated the electrode, yielding about 90 watts electrical output at 12 watts per square centimeter. The efficiency of the conversion of fission heat to electric energy depended on the external load and the operating conditions and reached as high as 10%.

Dr. S. W. Herwald, Westinghouse Electric Corporation, next spoke on "The Role of Industry in Energy Conversion Research." After speaking about the world's supply of fossil fuels and when they will be exhausted, he described the four known methods of energy conversion: fuel cells, thermoelectricity, thermionics, and magnetohydrodynamics (MHD). The prime interest in these systems is in increased efficiency.

The best fuel-fired generating plants today have an efficiency of about 40%. Fuel cells may reach between 75 and 90% and MHD systems about 60%, while thermoelectric generators have efficiencies of about 30%. The drawback to all these systems is that the materials from which they are constructed are not economically feasible at present and it may be years before they are. The main reason for this condition is the very high temperatures to which these materials are subjected.

Dr. R. W. Blue, Bendix Aviation Corp., had as his subject, "Exploring the Future of Direct Energy Conversion." He compared the fuel cell to a storage battery except that in a fuel cell a gas is used which is replenished by addition of more of the chemical cell material. He showed a series of slides in which the progress of the fuel cell's development was illustrated and then showed possible uses for it in the future. He concluded his talk with the fact that it is the responsibility of the mechanical engineer to devise better shapes and sizes of future cells and it is up to the electrical engineer to design lighter and smaller systems for d-c applications.

Dr. I. Wolf, RCA Laboratories, spoke on direct conversion from solar to electric energy. While solar energy is free, the main drawback is that storage of the energy is needed; even so, satellites are using this means for recharging storage cells in space.

Footing the Bills

The last speaker was Dr. R. W. Porter, General Electric Company, who talked about adventures in energy conversion. After a description of the four known methods of converting energy, he took up the question of who will foot the bills and who will do the research work. The Government can be expected to pay for the work if there are military possibilities in such devices, but if not, then private industry should pick up the tab. This is as it should be in this country of free enterprise and if the work is successful, then there will be sufficient compensation.

W. E. Hawkins Photos

SHOWN during Section Growth Awards ceremonies were: *(left to right)* Bob Gillette, chairman of the Sections Growth Award Committee, who presented the gavels and certificates; W. F. Payette Jr., Public Service Board of San Antonio, Texas; E. J. Moore, Wright Machinery Company, North Carolina Section; Richard Miller, Iowa-Illinois Gas & Electric Company, Iowa-Illinois Section; F. R. Bergseth, University of Washington, Seattle Section; and W. E. Scholz, Philadelphia, Pa., Sections Committee chairman.

AIEE Section Delegates Conference

Reviews Last Year and Plans for 1960-61

THE AIEE Section Delegates Conference was called to order by Chairman W. E. Scholz at 9:00 a.m. on June 21, 1960, in the Rutland Room of the Chalfonte-Haddon Hall Hotels in Atlantic City, N.J. G. B. Schleicher was secretary.

After introducing several officers of the Institute, Mr. Scholz presented AIEE President J. H. Foote, who welcomed the delegates and said also that some sort of a welcoming routine was a necessity for Section meetings. Mr. Foote advised that younger men be put on local technical committees so that they can gain experience for serving on national technical committees. There is integration needed between Section and Subsection activities, he asserted, and because the various technical conferences need better publicity at the Section level, they should be given appreciation and co-operation by the Sections.

The next speaker was AIEE President-Elect C. H. Linder, who in his present role as treasurer of the Institute stated that if the finances of an organization are in order, then the organization itself is in order. By means of several slides, he showed the state of the Institute's finances. The reserve capital fund is now up to $1.2 million in 1959 from $550,000 in 1950-51. A pie-chart of income showed the following percentages: dues and fees, 52.8%; advertising, 23.7%; publication sales, 15.6%; investments, 3.3%; registration fees, 3.2%; Standards sales, 1.2%, and other income, 0.2%. In the expenditures chart, the Publications Department led the list, as is to be expected.

Mr. Linder urged that more joint society technical conferences be held, and a slide showed that the popularity of this type of conference was on the increase. Another slide revealed that there was an increase in conference attendance and listed the number of technical papers presented at conferences.

Institute Budget

The AIEE Treasurer for 1960-61, W. R. Clark, who served as chairman of the Finance Committee during the previous year, reviewed the Institute budgets for the last few years. Since the Institute had been operating at a loss in several instances, it was determined that the 1960-61 budget should be more realistic. This was accomplished by making a few drastic changes in the budget, with the result that an estimated profit of approximately $70,000 is anticipated at the close of the present fiscal year.

Dr. Clark stated that the Sections could help the situation by increasing their membership, which not only would help the finances of the individual Sections but also those of the Institute.

D. E. Garr, chairman of the Student Branches Committee, introduced John Morrison, the new headquarters secretary, who will co-ordinate the work of this committee. After commenting on the work of his committee with schools and colleges, Mr. Garr by means of a series of charts showed the delegates how they could co-ordinate their Section's work with that of his committee. He told about thirty Sections which have been briefing students by means of 5-man panels on campuses. He suggested that the personnel of such panels be varied; i.e. with representatives from research, design, sales, purchasing, etc., so that the students could get a broad picture of what lies in store for them when they graduate.

The suggestions were made that such panel meetings be held in connection with dinners and that the students' wives be invited also, inasmuch as the ladies play a large part in their husbands' futures.

Section Growth Prizes

Chairman Scholz then made the Section Growth Awards, which were as follows:

In the larger-than-average Section group, the gavel, indicating first place, was awarded to the Seattle Section with a growth factor of 36.333. The North Carolina Section, in second place, was awarded a certificate, and the next three Sections in order of growth were Washington, East Tennessee, and Denver.

In the smaller-than-average group, the first-place gavel was awarded to South Texas, with a growth factor of 77.210 and a certificate was given to the Iowa-Illinois Section in second place. The next three in order were Utah, Wichita, and Ottawa.

Three of the Sections which were included in the first five in the larger-than-average group last year were again among the first five this year, thus indicating a continuing high degree of Section activity.

W. J. Barrett, AIEE past president, gave a progress report on the new United Engineering Center in New York City by means of a series of slides. Among them was a photograph of ex-President Herbert Hoover laying the cornerstone of the new building on June 16.

Chairman Scholz then introduced Howard Sheppard of the Member Gifts Campaign Committee, who stated that the AIEE was within 7% of its $900,000 quota. He reported that 24 Sections have been successful in meeting their quotas and that it is now the responsibility of the Sections who have not as yet met their quotas to raise the remainder. Mr. Sheppard said that Sections could solicit money from those companies who are not on the Kelly list of manufacturers, and that another good source is the several thousand new AIEE members who have come into the Institute since the fund-raising campaign was started about 2 years ago.

After Mr. Sheppard's remarks, the delegate from the Lehigh Valley Section contributed a $500 check, sent from his Section's treasury. The Seattle delegate announced that his Section had mailed a check for $1,000, and the Milwaukee delegate stated that his Section had voted to send a check for $500.

Public Relations

To enliven the afternoon session, the Public Relations Committee of the Institute obtained a 5-piece band, which played "corny" tunes as the players first marched through the lobbies of Haddon Hall and the Chalfonte Hotels, and then up to the room where the conference was being held. *(Editor's note: The music was loud; its quality doubtful.)*

C. F. Savage, chairman of the AIEE Public Relations Committee, conducted the Public Relations Workshop. In his opening remarks, Mr. Savage said the music was employed in the way public relations "hoopla" used to be; but now there is a more refined touch. To illustrate this, a panel was seated on the stage, consisting of J. O'Connor of *Power*; Sam Schore, *Atlantic City Press*; Ben Skrotzki, *Power*; and Tom McCauley. Mr. O'Connor, after defining public relations, said that the Sections should have sound public relations so that the AIEE story is spread around properly and that the Sections should know all there is to know about the Institute.

Mr. Schore gave advice as to how to get notices in the daily papers and Mr. Skrotzki told about magazine material, such as notices of special meetings, personnel notices, etc., and stressed that these should be in the editor's hands sufficiently before press time so that the editor has enough time to prepare them.

Mr. McCauley, who has conducted radio interviews on "Meet the Engineer" for many years in Philadelphia, played a number of interesting tapes of such interviews and stated that he would make available at a nominal price any of these tapes to Sections which desired to enhance their public relations efforts. For a list of tape interviews, write to Mr. McCauley, 538 Rose St., Yeadon, Pa.

C. L. Brown, Portland, Oreg., stated that his Section maintained good public relations in that city's school system by supplying speakers for high schools and industrial meetings.

A. J. Hornfeck, Cleveland, Ohio, told how his Section sent news letters to their members and their wives.

R. C. Mayer, Jr., of the Institute's public relations advisers, stated that a public relations newsletter would be sent in the near future to all Sections. Mr. Savage then advised the delegates to give their public relations chairmen the kit, which was distributed, and requested that reports on this activity be sent to him.

AIEE Membership

In discussing Section membership, D. T. Michael, vice-chairman of the Membership Committee, pointed out that the AIEE membership had been increasing up to 1952 by about 10% annually, but that the percentage had dropped to about 3%. He advised the Sections to appoint strong membership committees and give them specific assignments. Mr. Michael maintained that Sections should have strong representation on national committees and that there should be personnel development committees at the Section level.

With regard to Section activities, Mr. Michael said there should be more educational work and study at the grass roots level. It is estimated that about one-third of the Sections are engaged in some sort of work of this type, and about 75% of the men taking such courses are not members of AIEE.

In a discussion of membership transfers, G. R. Wilhelm, chairman of the Transfers Committee, described his committee's work and said that such work is service within each Section. He noted that almost 2,000 men have not yet paid their 1960 dues and urged Sections to have their members pay their dues to headquarters promptly. He recommended that Sections aid prospective members to fill out application forms and see that these are correctly processed.

T. M. Linville of the Intersociety Relations Committee and chairman of the Task Force to promote unity, suggested that the Sections hold unity meetings and conduct membership polls on this subject. He reported on four such meetings and asked that reports be sent to the Executive Secretary. He stated that the Task Force had 60 members and that they are available to address any Section meetings on the subject of unity.

Section and Subsection Changes

Chairman Scholz then announced the new Sections and Districts and changes.

The following new Sections and Subsections were formed bringing the total number of Sections in the Institute to 117:

The Vermont Section, which was formerly a Subsection of the Pittsfield Section, was granted full Section status on April 1, 1960. All the counties in the State of Vermont have been assigned to this new Section.

The Central Florida Section, which was formerly a Subsection of the Florida West Coast Section was granted full Section status on May 1, 1960. The six Florida counties of Brevard, Lake, Orange, Osceola, Seminole, and Sumter have been assigned to this new Section.

The Hudson Valley Section, which was formerly a Division of the New York Section, was granted full Section status on June 1, 1960. The six New York counties of Dutchess, Orange, Putnam, Rockland, Sullivan, and Ulster have been assigned to this new Section.

The new Channel Counties Subsection of the Los Angeles Section was formed, effective March 1, 1960. The three California counties of San Luis Obispo, Santa Barbara, and Ventura have been assigned to this new Subsection.

The new Southeastern Massachusetts Subsection of the Providence Section was formed, effective March 1, 1960. The Massachusetts counties of Barnstable, Dukes, and Nantucket: and in Bristol County the towns of Fall River, Freetown, Westport, Dartmouth, New Bedford, Fairhaven and Acushnet have been assigned to this new Subsection.

The new Gainsville Subsection of the Jacksonville Section was formed, effective April 1, 1960. The 20 Florida counties of Alachua, Bradford, Citrus, Columbia, Dixie, Franklin, Gadsden, Gilchrist, Hamilton, Jefferson, Lafayette, Leon, Levy, Liberty, Madison, Marion, Suwannee, Taylor, Union, and Wakulla have been assigned to this new Subsection.

With the formation of three new Subsections and the transfer to full Section status of three former Subsections or Divisions the total number of Subsections in the Institute remains at 77.

At the General Administration Department meeting of February 3, 1960, the transfer of Lawrence County in Indiana from the Louisville Section in District 13 to the Bloomington Subsection of the Cen-

CHECKS for the United Engineering Center were presented at the Section Delgates Conference by the Seattle and Milwaukee delegates: (*left to right*) F. R. Bergseth, delegate, Seattle Section; W. E. Scholz, secretary of the AIEE Member Gifts Campaign, and chairman of the Sections Committee; B. G. Wheeler, Milwaukee Section delegate; and H. H. Sheppard, vice-chairman of the AIEE Member Gifts Campaign.

tral Indiana Section in District 5 was approved. This transfer of territory becomes effective on August 1, 1960.

At the Sections Committee meeting of June 20, 1960, the transfer of the towns of Marion, Mattapoisett, Rochester, and Wareham in Plymouth County, Mass., from Boston Section to the Southeastern Massachusetts Subsection of the Providence Section, all within District 12, was approved. This transfer of territory becomes effective on August 1, 1960.

District Changes

Effective August 1, 1960, District 7 will be divided as follows:

Mid-America District 7, Sections—Arkansas, Kansas City, Oklahoma City, St. Louis, Tulsa, and Wichita.

Southwest District 15, Sections—Beaumont, Corpus Christi, El Paso, Houston, Mexico, Northern New Mexico, North Texas, Pan Handle Plains, Shreveport, and South Texas.

W. W. Middleton of the Sections Committee spoke about the pamphlet issued by the Engineers' Council for Professional Development, "The Five-Year Plan," and urged that it be read closely and used by the Sections. More information will be sent regarding this plan.

There were several questions directed at Mr. Linville concerning the matter of unity. He told how the plan had been received by several other societies and asked for improved communications between the Sections and headquarters. There were also questions raised from the floor concerning the status of affiliates, which again raised the question of memberships in general, and Mr. Scholz urged that Sections process applications for membership.

The meeting was adjourned at 5:00 p.m.

AIEE-IRE Co-operation Reported at Technical Committee Chairmen Forum

AT the 23rd Forum of Technical Committee Chairmen, progress was reported in the areas of reciprocal membership relations and a Joint AIEE-IRE (Institute of Radio Engineers) Standards Committee, the need to expand technical committee membership work, and the mailing of Institute periodicals. The forum, held on June 23, was opened by C. T. Hatcher, chairman of the Technical Operations Department, who explained that in the future there would be one technical vice-president from each of the six Divisions on the Board of Directors.

AIEE-IRE Co-operation

W. S. Hill, who is chairman of an AIEE Task Group comprised of E. I. Green, L. C. Holmes, and G. H. Brown, described a meeting held with a similar IRE Task Group comprised of three past-presidents, Chairman D. G. Fink, Haraden Pratt, and J. D. Ryder, to consider long-range plans and explore areas of co-operation. At the joint meeting, held April 25, it soon became apparent that immediate progress could be made in the areas of reciprocal membership and standardization. At a subsequent meeting of the Task Groups, the following resolution was unanimously adopted:

> WHEREAS the American Institute of Electrical Engineers and the Institute of Radio Engineers are professional societies with professional stature, and since both societies have efficient and critical screening procedure for admission to the various grades, the AIEE and IRE Task Groups recommend to their respective societies that they adopt appropriate procedures, to become effective on October 1, 1960, whereby a member of one society may, based solely on qualifications submitted to that society, join the other society at an equivalent grade of membership up to but not including the grade of Fellow without payment of the entrance fee. Implementation of this policy shall be assigned to the Chairman of the AIEE Board of Examiners and the Membership Co-ordinator of the IRE Executive Committee.

This resolution was approved by the AIEE Board of Directors on June 24 and the principle was previously approved by the IRE Board of Directors.

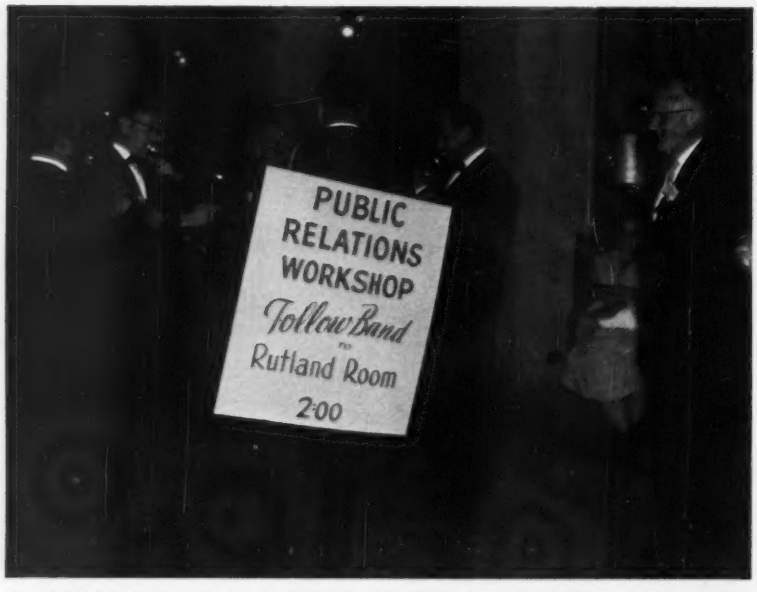
In conclusion, Chairman Hill stated that inasmuch as there already was co-operation at the Section level and in the sponsorship of joint technical conferences, there was hope that approval of the resolution would pave the way for other areas of co-operation.

Standards Collaboration with IRE

A status report leading to the proposal for a Joint Standards Committee of AIEE-IRE was outlined by J. P. Jordan, chairman, AIEE Standards Committee. It was explained that in 1940 the need arose for the assignment of a band in the frequency spectrum for electric heating. At the hearings, the AIEE group and the IRE group met and became acquainted with the common objective, and space was approved for that allocation. Mr. Jordan explained the need to produce Standards with a minimum of duplicated effort and the elimination of conflicting Standards. However, a situation has been developing in the electronics field where duplication and conflict have had an alarming increase. After analyzing active projects in the technical committees, Mr. Jordan concluded that approximately 50% of all of our new Standards activity has an active counterpart in IRE.

Because of the need of obtaining standardization approval procedures in the two societies, arrangements were made with R. F. Shea, chairman of the IRE Standards Committee, last November, to appoint an ad hoc committee of the Standards Committee to work with the IRE Standards Executive Committee. It was determined that a Joint Standards Committee with authority to approve all Standards of mutual interest would be the most expedient approach. The Joint Committee would be comprised of an equal number of personnel selected from the two societies and would have complete authority to approve Standards in the names of the two societies; therefore, the following resolution was proposed:

> WHEREAS, the AIEE and IRE are engaged in the preparation of Standards in related or overlapping areas of electrical science and technology, and
>
> WHEREAS, it is desirable that the efforts of the two societies in preparing such Standards be co-ordinated to avoid duplication of effort and to resolve conflicting Standards, and
>
> WHEREAS, it is desirable that a single



PUBLIC RELATIONS "hoopla" was displayed with a 5-piece band, which paraded through the lobbies of the Haddon Hall and Chalfonte Hotels preparatory to the afternoon session of the AIEE Section Delegates Conference. Robert Ferris (*right*) was chairman of the Public Relations Committee for the Summer General Meeting.

Standard be submitted to the American Standards Association in fields covered by the two societies,

BE IT RESOLVED that the Joint IRE-AIEE Task Group unanimously recommends to their parent societies that a Joint AIEE-IRE Standards Committee be appointed by, and with the power of, the respective Boards of Directors, and that the Joint Standards Committee be empowered to approve, jointly in the names of the societies, such Standards as the said Joint Committee determines, on its own cognizance, are suitable for joint promulgation, and

BE IT FURTHER RESOLVED that, on the approval of the above recommendation by both societies, it is recommended that the detailed implementation of the Joint Standards Committee organization and operation be assigned to the existing Ad Hoc Joint Committee on AIEE-IRE Co-operation on Standards.

The foregoing resolution was approved by the AIEE Board of Directors on June 24 and subsequently will be acted upon by the IRE Board of Directors.

Technical Committee Membership Activity

In the light of rapid growth and expansion within the industry, AIEE President J. H. Foote made a strong appeal to the chairmen of technical committees to think about new areas of activities and about putting committee people to work in those areas to keep them happy. He stated that the doubling of the membership in a certain period of time does not necessarily keep pace with industry inasmuch as many members die and others retire. Industry itself has grown tremendously in recent years, for example, the whole modern concept of telemetering in the last 7 years has been revolutionized; more than 1,400 people attended the Telemetering Conference in Santa Monica.

To illustrate the expansion of technology, President Foote outlined six areas: (1) theory, (2) applications, (3) microsystems, (4) utilization in a system, (5) maintenance, and (6) standardization. As an illustration of activities in the foregoing areas, President Foote drew attention to the following conferences:

1. Theory was exemplified by the Solid State Devices Conference in Philadelphia attended by 3,000 people.
2. Applications were illustrated by the Electronics Industry Conference and Electronics Components Conference.
3. Implementation was demonstrated by the National Electronics Conference in Chicago and the Telemetering Conference at Santa Monica.
4. Utilization was illustrated by the Automatic Control Conference in Dallas as well as Electrical Techniques in Space Conference.
5. Maintenance and automatic control were exemplified by the Machine Tool Conference.
6. Standardization was illustrated by the Control Systems Standardization Conference.

In conclusion, President Foote stated that AIEE people have to be put to work. He had heard of certain members who wanted to become active but who found no place in the AIEE organization; they eventually became active in the Instrument Society of America, professional groups, and the Technical Association of Paper and Pulp Industry.

Mailing Institute Periodicals

The economic advantages of mailing Institute periodicals second class under the provisions for special rate publications, as well as the qualifications necessary to obtain second class mailing privileges were explained by the Editor. Second class mailing privileges granted to certain fraternal, religious, scientific, and educational nonprofit organizations result in savings of 300 to 350% or more, in comparison with the second class rates for commercial publishers. The advantages have become more important in recent years because the Post Office Department has periodically increased the rates for second class as well as other classes of mailings but the special rate publications have not been subjected to these increases.

Three of the principal qualifications for permission to mail second class are:

1. Publications must be formed of printed sheets. They may not be produced by the stencil, mimeograph, or hectograph process, or in imitation of typewriting.
2. A minimum frequency of four times a year must be established, and that frequency must be maintained.
3. Pages must be numbered consecutively and extraneous matter cannot be included in the publication.

In the discussion, Past-President L. F. Hickernell drew attention to the importance of complying with second class mailing qualifications when considering technical group publications; otherwise, there would not be sufficient funds for the publications.

In connection with the proposal for a Joint Standards Committee of the AIEE-IRE, B. G. Ballard extended hearty congratulations to the Joint Task Group for having done the work but raised the question that a liaison representative between the Standards Committees and the Joint Standards Committee seemed necessary. Mr. Jordan explained that all members of the AIEE Standards Committee and the IRE Standards Committee would be liaison members on the Joint Standards Committee.

The General Administration Department director, C. T. Pearce, made an appeal for broader representation from the Sections and from the academic field on the technical committees, which would be helpful in membership work.

55 Items of Business Acted Upon at June Meeting of Board of Directors

THE regular June Meeting of the Board of Directors was held on the last day of the 1960 Summer General Meeting with 26 of the present 30 voting members in attendance. Also present were the four Department Chairmen and seven Vice-Presidents-Elect.

Fifty-five items of business were acted upon in the 6-hour session. Several decisions were reached on major matters of policy. A brief outline of some of the more important actions of general interest follows.

Finance

The reports of the Treasurer, Finance Chairman, and the Auditor were approved, and the budget, previously approved by the Executive Committee, was accepted without amendment. As indicated by the financial statements appearing on pp. 688-90 of this issue of Electrical Engineering, income for 1959-60 exceeded expenses by $71,000 and the Reserve Capital Fund stood at approximately $1.2 million on April 30, 1960. The budget for 1960-61 calls for a small surplus. Heavy capital expenditures are anticipated in the coming year in connection with moving, furnishing, and equipping quarters in the new United Engineering Center which is scheduled for occupancy in July 1961.

Constitutional amendments presented to the membership in the ballot of March 28, 1960, were approved. A completely revised set of Bylaws compatible with the new Constitution, as adopted in 1959 and amended this year, has been under development for 2 years. These Bylaws were approved by the Board and will be published after authorized editing is completed.

Exhibit

Approval was given for the sponorship of an Electrical Engineering Exposition biennially in connection with the Winter General Meeting beginning in 1962. The Executive Committee was authorized to enter into a suitable contract for the production and management of these exhibits with the understanding that their purpose is to serve as an educational supplement to the Winter General Meeting program.

A resolution was voted reaffirming AIEE's support and advocacy of the Functional Plan for handling intersociety activities among the several joint Councils and the National Society of Professional Engineers and the desirability of continued effort jointly with other interested societies to develop effective co-operation.

Specific steps were taken to promote co-operation within the electrical engineering profession. Resolutions were voted approving the extension of joint activities with the Institute of Radio Engineers (IRE) in the fields of Standards, reciprocal membership privileges, and Student Branches. These important actions grew out of conversations between committees of the Boards of the two Institutes initiated by proposals made by the IRE Board.

The Board voted to offer to assume the Secretariat of the International Electrotechnical Commission, Technical Commit-

tee No. 25, "Electrical Letter Symbols and Signs," and made the necessary appropriations for the support of this work.

Elections

Constitutional amendments adopted by membership vote, as reported at the Annual Meeting June 20, 1960, create, as of August 1, 1960, four Department Directors and six Technical Vice-Presidents as voting members of the Board. These offices will, in the future, be filled by the regular processes of nomination and election. To fill the vacancies prior to the next election in June 1961, the Board, under its Constitutional authority, elected the following to serve until July 31 of the year indicated.

Department Directors: General Administration, C. T. Pearce, to 1961; Professional Development and Recognition: B. G. A. Skrotzki, to 1962; Publications, W. F. Denkhaus, to 1961; Technical Operations, F. L. Lawton, to 1962.

Technical Vice-Presidents: Communications Division, F. H. Bramhall, to 1961; General Applications Division, L. R. Larson, to 1961; Power Division, J. H. Kinghorn, to 1961; Industry Division, J. F. Deffenbaugh, to 1962; Instrumentation Division, P. K. McElroy, to 1962; Science and Electronics Division, E. L. Harder, to 1962.

Other elections included the following: To represent the Board of Directors on the Edison Medal Committee, J. H. Foote. C. T. Hatcher, and C. T. Pearce.

On the Engineers' Council for Professional Development, W. H. Chase.

On the Board of the United Engineering Trustees, J. F. Fairman.

On the Board of the Engineers Joint Council for a 2-year term, W. R. Clark, S. M. Osthagen, and C. T. Pearce, and to replace President-Elect C. H. Linder to January 31, 1961, Hendley Blackmon.

Fellows Elected: Ten members were elected to the grade of Fellow as will be reported in a subsequent issue of *Electrical Engineering*.

General and District Meetings Approved

General and District Meetings were approved as far ahead as 1966. A complete schedule will be published in the September issue of *Electrical Engineering*. Major changes involve the 1964 Fall General Meeting to be held in Houston, Texas. The 1962 and 1963 Fall General Meetings will be held in Chicago with headquarters at the Sheraton Towers Hotel.

Wear Your ◆ AIEE Badge

Student Members

Only one grade of Student Membership and one type of Student Branch will exist after August 1, 1960. Bylaw amendments and implementing resolutions approved by the Board will abolish the Affiliate Branch and the Student Affiliate grade of membership. Existing Branches and Student Members will be given the "Associate" label for the coming year in anticipation of Constitutional amendments ultimately creating simply "Student Members" and "Branches" without qualifying adjectives. Other changes in membership qualifications are to be instituted in the new Bylaws growing out of the recognition given the scientist and the science curriculum in recent Constitutional amendments.

Report of the AIEE Board of Directors*
May 1, 1959-April 30, 1960

THREE MEETINGS of the AIEE Board of Directors were held in Seattle, Wash.; Chicago, Ill.; and New York, N.Y. Two Executive Committee meetings were held in New York, N.Y., in place of Board meetings. Information regarding the more important decisions of the Board was given in various issues of *Electrical Engineering*.

Three General Meetings of the Institute were held: Summer and Pacific, Seattle, Wash.; Fall, Chicago, Ill.; and Winter, New York, N.Y.

Four District Meetings were held: Middle Eastern, Baltimore, Md.; South West, Houston, Texas; East Central and Allegheny-Ohio Valley (combined), Charleston, West Va.; and Great Lakes, Milwaukee, Wis.

The Institute wholly or partly sponsored 33 Special Technical Conferences and the total attendance at all meetings and conferences was 40,860, a total of 2,440 papers being presented.

Constitution and Bylaws Committee

Following acceptance by the membership of a simplified Constitution, the Committee began revising the Bylaws so that they would agree with the numbering system in the new Constitution. On February 5, 1960, the Board voted to accept the recommendations of the Special Task Force and the Planning and Coordination Committee. This action required further changes in the Constitution, which were submitted to the membership in April 1960.

During the year, the Committee provided for revisions in the Bylaws, as recommended by the several Departments.

The renumbering and revision of the Bylaws still is in process to produce a format similar to that of the new Constitution.

Finance Committee

During the past year, all activities of the Institute were reviewed to determine whether the operating costs were justified by the benefits to the members. Meeting registration fees were adjusted and prices of AIEE *Transactions*, preprints, and Standards were increased. Short-term investments were utilized to obtain $2,958 addition to the income. Efforts were made to increase advertising income to its previous level and restrictions were placed on the number and length of Transactions papers accepted during the year.

These changes resulted in the year's income exceeding expenses by $71,862 in spite of establishing the *EE Digest* for students, adding a Headquarters staff man to care for Student Branch activities and a paid secretary for the Technical Operations Department.

For the Institute's balance sheet and the statement of income and operating fund reserve for the fiscal year ending April 30, 1960, see the end of this summary.

Planning & Coordination Committee

The work of this Committee at its four meetings during the year was directed along the following lines: department reorganizations; co-operation with the Institute of Radio Engineers (IRE); reconstitution of the Board and Executive Committee; dues and fees; exhibits at General Meetings; meetings and schedules; and manuals and information for officers.

Intersociety Relations Committee

This 9-member Committee was established by the Board on October 16, 1959, with these responsibilities: advising the Board on matters of policy with respect to current intersociety affairs; representing the Institute in negotiations of new intersociety relations; formulating methods for applying Institute policy to intersociety problems; promoting the implementation of Institute policies and programs in the field of intersociety relations; carrying out any related activity assigned to the Committee by the Board. There are three subcommittees concerned with AIEE-IRE interrelationships; unity; and Engineers Joint Council (EJC) and Engineers' Council for Professional Development (ECPD) activities.

***This is a summary of the Report of the Board of Directors. Anyone wishing a copy of the complete report should write to: The Secretary, AIEE, 33 W. 39th St., New York 18, N. Y. Copies of the complete report have been mailed to all AIEE general and technical committee chairmen.**

Membership Committee

The total membership of the Institute on April 30, 1960, was 55,491, an increase of 1,664 members, slightly more than during the previous year. New members increased by 3.5%, but former members reinstated declined 21% from last year.

Public Relations Committee

In connection with the 75th Anniversary of the Institute, the Committee undertook to publicize the AIEE Founders' Day luncheon at the Sheraton-Astor Hotel in May. The special Anniversary exhibit booth was displayed at a dozen AIEE meetings and a feature Anniversary story, "The Most Powerful Man in the World" was released to some 60 publications.

An 8-page newspaper, designed especially for students, was published for the Student Branches Committee. Five issues of this were distributed to about 30,000 students in the 164 Student Branches of the Institute.

The Committee also published a series of leaflets describing the objectives and functions of 18 of the Institute's major technical committees. New issues of "AIEE Today," a new student leaflet, and a syndicated AIEE radio script were distributed.

Two public relations workshops were held at the Summer and Winter General Meetings and public relations booklets were sent to all Sections.

About 300 news releases were written and distributed during the year, and on-the-spot news coverage was given to the AIEE General Meetings.

Sections Committee

During the year, three new Sections were formed, bringing the total to 115. The total number of Subsections is now 79, an increase of 2 during the past year.

The first and second places in the Section Growth Awards were won by Denver and Washington Sections in the larger-than-average group. In the smaller-than-average group, Jacksonville Section won, with the Hamilton Section in second place.

The total number of meetings decreased from 2,690 in 1959 to 2,615 in 1960, but the total attendance increased from 130,874 in 1959 to 137,261 this year.

Student Branches Committee

AIEE Student Branch membership was 10,992 as of May 1, 1960, a decrease of 4.6% from the year before. There was one new Branch established in 1960, bringing the total to 164. Some 1,521 meetings were held with a total attendance of 87,495.

Transfers Committee

It was indicated by the Committee that from a total membership of 50,363 as of August 1, 1959, there was an average of 3.42 transfers per hundred members. From data sent by the Sections, it was seen that in 76 of the 112 Sections reporting, 53 have separate transfers committees and 23 handle transfers activities otherwise.

Professional Development & Recognition Department

In its two meetings this year, the Department approved the design for the medal for the Mervin J. Kelly Award in the field of Telecommunication.

The Department is preparing operating manuals for the guidance of award committees. It also reviewed the ECPD suggestion for an AIEE committee to promote the development of young engineers and approved the distribution of the material published by ECPD for its Committee on the Development of Young Engineers. The Department also recommended to the Board approval of the change in the ECPD Charter, which had been referred to the participating societies. This was approved by the Board.

Board of Examiners

During the year, the Board of Examiners, at its 11 meetings, acted upon 4,937 admissions and 1,008 transfers.

Medals and Awards

The following medals and awards were presented during 1959-60:

Edison Medal to James F. Fairman, Consolidated Edison Company.

Lamme Medal to Lee A. Kilgore, Westinghouse Electric Corporation.

AIEE Medal in Electrical Engineering Education to Gordon S. Brown, Massachusetts Institute of Technology.

Charles LeGeyt Fortescue Fellowship Award to Jeffrey I. Frey, Cornell University.

William M. Habirshaw Medal to William A. DelMar, retired.

Morris E. Leeds Award to Herbert B. Brooks, retired.

David Sarnoff Medal to David Sarnoff, Radio Corporation of America.

Recognition Awards Committee

This Committee was augmented to a membership of 18; a special Bylaw establishing a regular 4-year term with 24 members was accepted by the Board.

Designs for the Mervin J. Kelly Award in Telecommunication and the David Sarnoff Award in Electronics were completed and the awards will be made at the Fall General Meeting in October 1960.

Registration of Engineers Committee

The Committee reviewed drafts of the new proposed Model Law. Since the February meeting of the Committee, the final draft of this Law has been completed and AIEE was invited, along with other engineering societies, to present their views at a meeting in May. (See explanatory article in this issue of *Electrical Engineering*, pp. 631-33).

Alessandro Volta Memorial Fund

The Volta Fellowship for the current year was awarded to Franco Mariotti, a graduate of the University of Padua. He will study at the University of California.

Publications Department

During the year, a total of 35 general articles, 82 technical articles, and 68 one-page digests were published in *Electrical Engineering*. Of the 82 technical articles, 51.2% had electronic subject matter. The general articles were in the fields of education, management, research, safety, standards, and the medal presentations.

While the dollar volume of advertising income in the magazine has increased 3.22% over the previous year, it is about 20% below the peak year preceding the business recession.

Volume 78 of the AIEE *Transactions* 1959, containing over 3,500 pages of technical papers presented during the calendar year, was published in four parts.

Five Special Technical Conference publications were produced during the year with a total of 1,308 pages. A special publication of 76 pages was produced, bringing the total number of pages to 1,384.

A total of 10,616 pages were produced by the staff during the year.

Technical Operations Department

As a result of the approval of the Board of certain of the Lewis Committee's recommendations, the new Technical Activities Committee established by TOD in 1958 was recommended for transfer to an Institute standing committee. This was approved by the Board in February 1960.

The Lewis Committee recommendations provided for the establishment of Technical Groups within the Institute, and the Department is now working on rules and regulations to govern these Groups.

In accordance with Board action, the position of a Manager of Technical Operations Services was established as of January 1, 1960. I. S. Coggeshall was secured for this position.

Two full Committee meetings were held and three by the Administrative Committee.

In addition to the 12 subcommittees of TOD, four General Committees carry on special work; these are: Automation and Data Processing, Man-Machine Integration, New Technical Activities (now a general committee of the Institute) and Nuclear Congress and Nucleonics.

Three Forums of Technical Committee Chairmen were held during the year.

Research Committee

A National Science Foundation (NSF) bulletin on programs for aid to science education was sent to heads of electrical engineering departments of accredited schools with a letter from the Committee encouraging more participation by such institutions with the NSF program.

A subcommittee is surveying basic research areas of interest to electrical engineering under three headings: Energy Conversion, Properties of Materials, and Information Processing.

Safety Committee

Correlation between the requirements

(Continued on page 690)

HASKINS & SELLS
CERTIFIED PUBLIC ACCOUNTANTS

TWO BROADWAY
NEW YORK 4

Accountants' Report

American Institute of Electrical Engineers:

We have examined the balance sheet of American Institute of Electrical Engineers as of April 30, 1960 and the related statements of income and operating fund reserve and of restricted fund reserves for the year then ended. Our examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the accompanying balance sheet and statements of income and operating fund reserve and of restricted fund reserves present fairly the financial position of the Institute at April 30, 1960 and the results of its operations for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

(signed) ***Haskins & Sells***

June 7, 1960

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Exhibit A — **Balance Sheet, April 30, 1960 and 1959**

ASSETS

	April 30, 1960	April 30, 1959
Property Fund Assets:		
Founder Society advances to United Engineering Trustees, Inc. (not repayable except upon latter's dissolution; 4% interest payable from date of occupancy of United Engineering Center)	$ 265,000	$ 265,000
Other properties at nominal values (library, works of art, etc.)	16	16
TOTAL PROPERTY FUND ASSETS	$ 265,016	$ 265,016
Restricted Fund Assets:		
Investments:		
Securities (market value 1960—$1,694,252; 1959—$1,773,641)	$1,267,495	$1,266,882
Cash	20,719	17,140
Accrued interest purchased	440	—
TOTAL RESTRICTED FUND ASSETS	$1,288,654	$1,284,022
Operating Fund Assets:		
Cash	$ 53,075	$ 163,743
Accounts receivable:		
Members—for dues	41,758	39,510
Advertisers	26,718	5,402
Technical conference loans	12,050	9,350
Subscriptions, etc. (less reserves, 1960—$2,582; 1959—$2,797)	46,722	47,170
Inventories—at cost or less:		
Transactions	23,135	20,232
Text and cover paper	41,908	32,777
Badges	5,256	3,771
Production charges for May and subsequent issues of *Electrical Engineering*	10,486	39,540
Prepaid expenses	13,428	15,828
Office equipment, furniture, and fixtures (less reserve for depreciation, 1960—$77,082; 1959—$77,851)	50,729	40,427
TOTAL OPERATING FUND ASSETS	$ 325,265	$ 417,750
TOTAL	$1,878,935	$1,966,788

LIABILITIES

	April 30, 1960	April 30, 1959
Property Fund Reserve:		
Founder Society advances to United Engineering Trustees, Inc.	$ 265,000	$ 265,000
Other	16	16
TOTAL PROPERTY FUND RESERVE	$ 265,016	$ 265,016
Restricted Fund Reserves (Exhibit C):		
Reserve Capital fund	$1,199,518	$1,198,479
Member-for-Life fund	35,301	32,564
International Electrical Congress of St. Louis Library fund	6,616	6,615
Edison Medal fund	11,552	11,265
Edison Endowment fund	7,986	7,986
Lamme Medal fund	9,539	9,727
Mailloux fund	1,054	1,054
Volta Memorial fund	14,627	12,783
Kettering Award fund	2,461	2,274
Habirshaw Medal fund	—	1,275
TOTAL RESTRICTED FUND RESERVES	$1,288,654	$1,284,022
Operating Fund Reserve, Liabilities, etc.:		
Accounts payable	$ 123,469	$ 109,963
Accrued expenses	2,133	7,172
Deferred income, etc.:		
Dues	57,240	298,713
Subscriptions to publications, etc.	57,906	62,286
Other	12,655	5,550
Operating fund reserve (deficit) (Exhibit B)	71,862	(65,934)
TOTAL OPERATING FUND RESERVE, LIABILITIES, ETC.	$ 325,265	$ 417,750
TOTAL	$1,878,935	$1,966,788

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Exhibit B **Statement of Income and Operating Fund Reserve for the Years Ended April 30, 1960 and 1959**

	April 30, 1960	April 30, 1959
Income:		
Dues:		
Members	$ 890,377	$ 876,335
Students	45,618	46,091
	$ 935,995	$ 922,426
Fees:		
Entrance	$ 18,089	$ 20,209
Transfer	4,475	5,040
	$ 22,564	$ 25,249
Publications sales:		
Advertising	$ 429,280	$ 414,655
Electrical Engineering subscriptions, etc.	44,664	42,163
Transactions volumes	40,189	34,309
Bimonthlies subscriptions, etc.	79,380	37,428
Preprints, special and technical publications, etc.	117,717	86,539
	$ 711,230	$ 615,114
Other income:		
Meetings registration fees	$ 51,243	$ 35,103
Technical conferences—net	6,671	3,761
Income from investments:		
Reserve Capital Fund—Marketable securities	56,196	46,109
Reserve Capital Fund—Note of United Engineering Trustees, Inc.	—	7,013
Other	2,958	166
Standards sales (including binders)	20,239	19,193
Sale of member emblems	471	719
Miscellaneous	2,032	3,069
	$ 139,810	$ 115,133
TOTAL INCOME	$1,809,599	$1,677,922
Expenses:		
General Administration Department:		
Public Relations	$ 33,513	$ 37,367
Sections	159,992	161,198
Student Branches	47,884	44,413
Membership	6,099	12,894
Institute Districts	8,892	6,961
Other (including salaries, 1960—$25,358; 1959—$27,594)	44,480	57,660
	$ 299,960	$ 320,553
Professional Development and Recognition Department	$ 17,709	$ 15,285
Technical Operations Department:		
Institute Meetings	$ 73,583	$ 77,715
Technical Activities	33,074	31,691
Standards Committee	21,687	18,136
Other	12,374	5,320
	$ 140,718	$ 132,862
Forward	$ 458,387	$ 468,700

	April 30, 1960	April 30, 1959
TOTAL INCOME (Forward)	$1,809,599	$1,677,922
EXPENSES (Forward)	$ 458,387	$ 468,700
Publications Department:		
Electrical Engineering		
Advertising	$ 255,614	$ 254,725
Text	215,334	202,935
Transactions volumes	54,867	50,163
Bimonthlies	177,592	204,454
Electrical Engineering Digest	24,249	—
Membership directory and organization manual	17,690	21,600
Preprints, special and technical publications, etc.	121,605	126,950
	$ 866,951	$ 860,834
TOTAL DEPARTMENT EXPENSE	$1,325,338	$1,329,534
Non-Department Expense		
General:		
Salaries	$ 210,375	$ 208,585
Postage	6,111	7,087
Stationery and supplies	14,136	18,061
Contributions under retirement plan	29,731	28,741
Social Security taxes	10,546	8,228
Legal fees	500	500
Travel expenses of Directors and President	16,122	13,296
Depreciation of equipment, etc., (including accelerated depreciation, 1960—$250; 1959—$557)	6,687	6,577
United Engineering Trustees, Inc.:		
Building assessments (exclusive of amounts charged to other accounts, 1960—$11,055; 1959—$10,986)	37,815	36,951
Library assessments and pension	30,706	29,933
Rental of equipment	12,297	12,731
Conversion costs to punched cards	—	1,679
Other	31,941	35,411
	$ 406,967	$ 407,793
Constitution and Bylaws Committee	2,499	3,043
Finance Committee	1,889	2,200
Planning and Coordination Committee	29	48
Intersociety Relations Committee	1,015	1,238
TOTAL NON-DEPARTMENT EXPENSE	$ 412,399	$ 414,322
TOTAL EXPENSE	$1,737,737	$1,743,856
Excess (deficit) of Income over Expenses for the Year	$ 71,862	$ (65,934)
Operating Fund Reserve, (deficit) May 1	(65,934)	85,313
TOTAL	$ 5,928	$ 19,379
Transfer to Reserve Capital Fund (Exhibit C)	(65,934)	85,313
Operating Fund Reserve (deficit) April 30	$ 71,862	$ (65,934)

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Exhibit C **Statement of Restricted Fund Reserves for the Year Ended April 30, 1960**

	Total	Reserve Capital Fund	Members-for-Life Fund	International Electrical Congress of St. Louis Library Fund	Edison Medal Fund	Edison Endowment Fund	Lamme Medal Fund	Mailloux Fund	Volta Memorial Fund	Kettering Award Fund	Habirshaw Medal Fund
Balance, May 1, 1959	$1,284,022	$1,198,479	$32,564	$6,615	$11,265	$7,986	$ 9,727	$1,054	$12,783	$2,274	$1,275
Additions:											
Loan from operating funds	3,300								3,300		
Transfers between funds					193	(193)					
Income from investments	2,900	*	1,010	138	900	193	345	36	268	10	
Dues paid by members-for-life	6,899		6,899								
Contributions	492		315							177	
Profit (loss) on sale of securities	66,879	66,973							(94)		
TOTAL	1,364,492	1,265,452	40,788	6,753	12,358	7,986	10,072	1,090	16,257	2,461	1,275
Deductions:											
Purchase of medals, certificates, etc.	3,208		597		805		531				1,275
Library purchases	173			137				36			
District Branch Prizes:											
Traveling Expenses	4,123		4,123								
Prizes	516		516								
Scholarship awards	1,615								1,615		
Stationery, etc.	269		251		1		2		15		
Transfer to operating fund reserve (Exhibit B)	65,934	65,934									
TOTAL DEDUCTIONS	75,838	65,934	5,487	137	806		533	36	1,630		1,275
Balance, April 30, 1960 (Exhibit A)	$1,288,654**	$1,199,518	$35,301	$6,616	$11,552	$7,986	$ 9,539	$1,054	$14,627**	$2,461	—
Composition of Balances:											
Marketable securities	$1,267,495	$1,197,151	$26,951	$5,031	$ 9,131	$7,828	$ 8,932		$11,330	$1,141	
Cash in banks	20,719	1,927	8,350	1,585	2,421	158	607	$1,054	3,297	1,320	
Accrued interest purchased	440	440									
TOTAL	$1,288,654	$1,199,518	$35,301	$6,616	$11,552	$7,986	$ 9,539	$1,054	$14,627	$2,461	—

* The income of $56,196 from Reserve Capital Fund investments is credited to operating fund income (see Exhibit B).
** Balance at April 30, 1960 includes loan of $3,300 repayable to Operating Fund, like amount being included in accounts receivable subscriptions, etc. of latter fund.

(Continued from page 687)

of the National Electrical Code and the Canadian Electrical Code is an active item of work of the Committee and has received endorsement of the Board.

Standards Committee

Some 25 projects have been approved by the Committee. With 39 committees reporting out of the 50-odd technical committees, there are 87 Standards projects actively being pursued.

An ad hoc subcommittee of the Standards Committee has been established to work in collaboration with a similar group of the IRE to find a means to establish a joint approval of Standards material which has mutual interest, and to recommend methods for elimination of the duplication of efforts in the preparation of Standards material.

Technical Committees

The Report contains detailed reports from 54 of the Institute's technical committees concerning their activities during 1959-60.

Also included are reports on the year's activities from the following: ASA Standards Council; Council of the American Association for the Advancement of Science; Electrical Historical Foundation; Engineers' Council for Professional Development; Engineers Joint Council; International Commission on Illumination; National Academy of Sciences–National Research Council; United States National Committee of the International Electrotechnical Commission.

PLANS for the 2nd Power Industry Computer Application Conference were made when conference committee members met at the Chase Hotel in St. Louis, Mo., where the conference will be held on November 9-11. Committee heads for the conference are: *(left to right)* R. S. Gardner, AIEE headquarters; J. R. Burkhart, registration; J. E. Roomy, Prof. P. M. Honnell, and G. S. Whitlow, all of the St. Louis Section, AIEE; F. J. Maginniss, conference chairman; Dr. E. L. Harder, program; R. C. Hase, vice-chairman, finance; and D. P. Ayers, meeting facilities.

Power Industry Computer Application Conference Planned

"Computers for Engineering and Power" is the theme of the 2nd Power Industry Computer Application Conference, to be held on November 9-11, 1960, at the Chase Hotel in St. Louis, Mo. Latest developments in computers for utility engineering and plant automation and control will be presented. The meeting is co-sponsored by the Power Division and Computing Devices Committee of the AIEE.

Final date for technical papers is August 11, 1960. Conference paper synopses are due September 21, 1960. Final date for conference paper manuscripts is September 30, 1960.

VIEW of model SD-24, turbocharged diesel locomotive made at the Electro-Motive Division, General Motors Corporation, La Grange (Chicago suburb). A field trip to the General Motors Division is planned for the Fall General Meeting.

AIEE Chooses Chez Paree for Frolics during Fall General Meeting

THE Fall General Meeting, to be held in Chicago, Ill., October 9-14, will score a "first" when AIEE takes over the famous Chez Paree for its annual Fall Frolics. The Chez Paree cabaret features such top flight names in its shows as Jimmy Durante, Danny Thomas, and Red Skelton.

The Fall Frolics Committee, headed by Don Whitlow, Aluminum Company of America, has arranged this "first" for AIEE, which is taking over the entire club on Wednesday, October 12. A cash bar, exclusively for AIEE, will be open for a social hour beginning at 6 p.m. Dinner will be served at 7:30 p.m. Show time is 9 p.m. Dinner and the first show will be $12.50 per person, including all taxes and gratuities. No cover or minimum will be charged for the midnight show.

Joint Registration with NEC

Joint registration with the National Electronics Conference (NEC), introduced last year, will be available for the 1960 Fall General Meeting, according to F. D. Hurd, Westinghouse Electric Corporation, Registration Committee chairman. AIEE registration will be in the Morrison Hotel. NEC registration will be in the Sherman Hotel. Registration at either meeting will apply to the other.

Fifty-six technical sessions in all six divisions are being organized for this meeting. Monday, October 10, will offer sessions on Insulated Conductors, Power Generation, Chemical Industry, and Data Communication, there will also be a session sponsored by the Standards Committee.

Tuesday's sessions will be sponsored by the following Committees: Computing Devices, Power Generation, Substations, Relays, Feedback Control Systems, Data Communications, Broadcasting, Industrial and Commercial Power Systems, Protective Devices, and Semiconductor Rectifiers.

On Wednesday, sessions on Computing Devices, Semiconductor Rectifiers, Basic Sciences and Nucleonics, Substations, Power System Communications, Radio and Wire Communication Systems, and Rotating Machinery are being planned.

For Thursday, the following sessions are projected: Basic Sciences, Electronics, System Engineering, Switchgear, Rotating Machinery, Industrial Control, and Communication Switching Systems.

The meeting will close on Friday with sessions on Basic Sciences, Transmission and Distribution, Transformers, Switchgear, Rotating Machinery, Mining Industry, and Communication Theory.

Field Trips Planned

Eight field trips have been lined up, according to J. A. Schwenke, Line Material Industries, Field Trip Committee chairman. The trips include Commonwealth Edison Company's Maywood service shops, Cook Electric Company, Acme Steel Company, Commonwealth Edison Company's Dispatch Center, Electro-Motive Division of General Motors Corporation, Illinois Bell Telephone Company's Chicago No. 2 Toll Office, Chicago Sun-Times building, and Argonne National Laboratories.

All-Day Session on Data Transmission

A full-day session on data transmission will be held during the NEC and the Fall Meeting of AIEE in Chicago in mid-October. This session is co-sponsored by the NEC, the Communication Theory and the Data Transmission Committees of AIEE, and the Professional Groups on Communications Systems and Information Theory of the Institute of Radio Engineers.

The session will start with tutorial papers by R. M. Lerner on the design of waveforms for data transmission and by Prof. W. W. Peterson on current work in the field of coding. These will be followed by a series of panel discussions conducted by authorities in the fields of transmission characteristics, noise sources and noise models, measured error distributions in high-speed data systems, and other fields pertinent to the needs of the data transmission user, the information theorist, and the data transmission systems designer. These panel discussions will cover the material contained in all of the papers submitted to the Conference.

74th Annual Meeting of EIC Is Held in Winnipeg

A thousand members and friends of the Engineering Institute of Canada (EIC) attended the 74th Annual General and Professional Meeting held during May in Winnipeg, Manitoba. Every province from coast to coast was represented, as were sister societies in the United States and Great Britain. Max Freedman of the British *Manchester Guardian* came from his post in Washington, D.C., to speak at the annual banquet, at which the Mayor of Auckland, New Zealand, was among the head table guests. The Council met on Tuesday, while in other rooms of the Royal Alexandra Hotel the Committee on Education and the Branch Officers' Conference were also in session.

The annual general meeting received news of the appointment of a past president, Dr. J. B. Stirling, as chancellor of Queens University. As a novel aid to punctuality, all technical sessions were opened and closed with the skirl of the bagpipes. A lively panel discussion on the relative merits of the yard and the metre was attended by a large audience.

On the agenda were meetings of the Committee on Technical Operations and its various divisions, the Students' Conference, the Professional Development Committee, the Consulting Engineers, and the Joint ASME (American Society of Mechanical Engineers)-EIC International Council. Field trips to plants in the Winnipeg area were held.

At the Special Awards Luncheon, J. J. Hanna, EIC president, presented medals, prizes, and certificates of honorary membership.

The recipients of honorary membership certificates were: B. G. Ballard, vice-president of the National Research Council of Canada and director of the Division of Radio and Electrical Engineering; three engineers who have been closely associated with the Hydro-Electric Power Commission of Ontario, W. P. Dobson, R. L. Hearn, and Otto Holden; and J. N. Finlayson of Vancouver, a consulting engineer and formerly dean of the Faculty of Applied Science of the University of Columbia.

Julian C. Smith Medals which are awarded for "achievement in the development of Canada" were presented to C. D. Howe of Montreal, consulting engineer, and Hugh Young of Ottawa, deputy minister of the Department of Public Works of the Dominion Government.

The Leonard Medal which is presented for papers on mining subjects was won by Victor Dolmage and J. W. Stewart for their paper "The Demolition of Ripple Rock." These men are associated with the firm of Dolmage, Mason, and Stewart, Ltd., Geological and Mining Engineers of Vancouver.

The Plummer Medal was awarded to J. T. Hugill, manager of field operations,

Alabama Section Meeting

Lloyd Biggs

Sanford

AWARDS for prize papers were presented (above photo) at a recent meeting of the Alabama Section, AIEE, by W. C. Turner (right), Section chairman, to (left to right) J. C. Price, first place winner, for the paper, "A Transistor Radio Frequency Exciter Unit," and J. K. Hollingshead, second place winner, for the paper, "Emergency Traffic Warning Devices." AIEE President J. H. Foote (photo at left) addressed the Section on his visit to Russia. Student tours are an annual affair on "Student Night" in the Alabama Section, when students are guests of the Section at dinner, and prize paper awards are made.

Canadian Liquid Air Company Ltd., Montreal, for the best paper on a metallurgical subject.

The Duggan Medal and Prize was won by A. G. Davenport, research fellow and research assistant, Department of Civil Engineering, University of Bristol, England. He received the award for his paper "The Wind-Induced Vibration of Guyed and Self-Supporting Cylindrical Columns."

J. J. Traill, a consulting hydraulic engineer of Toronto, won the Robert W Angus Medal for a paper "Tests of Hydraulic Turbines—an Appraisal."

The Consulting Engineers at their annual dinner conferred honorary membership of their Association on Dr. C. J. MacKenzie, a past president of the EIC

Mr. Hanna, the retiring president, introduced the new president, G. M. Dick, at the annual banquet. Alderman Crawford, representing Mayor Juba of Winnipeg, gave certificates of honorary citizenship to President Dick, retiring President Hanna, past presidents Finlayson and Grant, ASME President W. L. Cisler, ASCE President F. A. Marston, Max Freedman, and Dr. R. L. Hearn. The same honor was conferred on Major-General H. A. Young. Lt. Gov. E. F. Willis bestowed a colorful Manitoba distinction, the Order of the Buffalo Hunt, upon President Hanna and the fraternal delegate from Great Britain, H. N. Allen, vice-president of the Institute of Mechanical Engineers.

District Student Contest Prize Paper Winners Announced

Winners of the AIEE District Student Prize Papers Competition have been named. In addition to the $25 Institute award to the first prize winner in the District, the Members-for-Life Fund has provided additional prizes which include a trip to the Summer General Meeting for the first prize winners, $25 for second prize, and $15 for third prize. Cash prize awards and certificates were prepared at AIEE headquarters.

Recipients of these awards, their colleges, and the winning papers are as follows:

District 1

1. M. N. Leeming, Union College, "A Dynamic Characteristics Tracer Using a Single-Crystal Barium Titanate Capacitor"
2. G. T. Roome, Syracuse University, "Solid-State Microwave Frequency Generation"
3. Charles Martin, Union College, "Construction and Operation of a Storage Tube Oscilloscope"

District 2

1. Alexander Graps, Jr., George Washington University, "Signal Flow Graphs"
2. H. S. Stone, Princeton University, "Minimization of Hazard-Free Switching Networks"
3. R. B. Swerdlow, University of Pennsylvania, "A Rotary Power Amplifier"

District 3

1. R. T. Modafferi, Manhattan College, "New Ideas in the Synthesis of Pipe Organ Tones Using Electronic Circuitry"
2. P. M. Brodie, Stevens Institute of Technology, "A Special Purpose Analogue Computer for the Solution of Integral Equations"
3. D. H. Friedman, Polytechnic Institute of Brooklyn, "Applying Audio Dynamic Compression to High-Fidelity Magnetic Recording"

District 4

1. W. F. Chambers, Duke University, "A Study of the Properties of Thin-Films of Iron-Cobalt at High Temperatures"
2. Chan-Hue Yeh, Virginia Military Institute, "Hydrox Fuel Cells and their Applications"
3. E. R. Pledger, Georgia Institute of Technology, "A Direct Reading Phase Angle Instrument for Low Frequencies"

District 5

1. Augusto Spencer, University of Notre Dame, "Thermoplastic Recording"
2. R. F. Pawula, Illinois Institute of Technology, "The Measurement of Noise Probability Density Functions"
3. W. M. Henebry, University of Illinois, "An Accurate and Reliable Pressure Control System for a Liquid Hydrogen Bubble Chamber"

District 6

1. R. F. Stanfield, University of Wyoming, "A Fully Automatic Variably Programmed Telephone Dialer"
2. Stuart Mitchell, South Dakota School of Mines and Technology, "A Two-Channel Record-Playback Tape Preamplifier"
3. F. G. Griffin, University of Colorado, "JANUS, An Electric Nurse's Aid"

District 7

1. F. H. Cleveland, A & M College of Texas, "Determination of a Mathematical Formula for the Hysteresis Loop and the Computation of the Hysteresis Loss in Magnetic Materials by Numerical Methods"
2. Bill Jones, University of Arkansas, "Atmosphere Whistlers"
3. Louis Thomason, Oklahoma State University, "The Operational Amplifier as a Q Meter"

District 8

1. C. S. Gillmor, Stanford University, "High-Frequency Extraterrestial Noise Investigations"
2. Ronald Ohlfs, University of Santa Clara, "Synthesis of Feedback Control Systems Using an Analog Computer"

District 9

1. R. M. Gardner, University of Utah, "Analog Computer Simulation of Heart Response to Nerve Stimulation"
2. R. J. Gregory, University of Washington, "A-C Circuit Interruption with an Air Disconnect Switch"
3. G. R. Marguth, W. E. Helm (co-authors), Oregon State College, "Binary Counter Using Rectangular Loop Magnetic Cores and Diodes"

District 10

(No contest)

District 11

1. J. C. Engel, University of Cincinnati, "Induction Motor Performance by Computer"
2. J. E. Balicki, University of Detroit, "An Improved Automotive Ignition Circuit"
3. D. L. Mills, University of Michigan, "Telemetry for Amateurs"

District 12

1. R. A. Shappy, University of Rhode Island, "Information Retrieval—A Scheme for Mechanically Searching Technical Literature"
2. N. D. McCrady, Bradford Durfee Institute of Technology, "The Hall Effect"
3. C. E. Miller, Yale University, "An Aural-Visual Field Strength Meter"

District 13

1. O. G. Gabbard, University of Kentucky, "A Low-Speed Thyratron Counter-Scaler Unit"
2. J. C. Price, University of Alabama, "A Transistorized Radio Frequency Exciter Unit"
3. E. A. Meyers, Jr., Christian Brothers College, "A New Automatic System for Determining the Frequency Spectrum from a Time Function"

District 14

1. G. A. Praver, O. A. Kolody (co-authors), Case Institute of Technology, "Marine Navigation Traffic Control System"
2. W. A. Lippold, West Virginia University, "Electrets"
3. J. P. Klosky, Charles Bulick (co-authors), Fenn College, "Arc Suppression"

German Atom Forum Invites AIEE to Conference

The German Atom Forum has invited the AIEE to send a representative to the Conference on the Application of Nuclear Energy, which will be held October 11-13, 1960, in Karlsruhe.

An item describing the planned meeting appeared in the July issue of *Electrical Engineering*, p. 608.

Individuals who are interested in attending the conference may obtain invitation cards from: The Secretary, AIEE, 33 W. 39th St., New York 18, N. Y.

The cost of admission will be 25 German marks, valued at about $6, which will pay for a program, lectures, and discussions.

Section Officers Installed

MEMPHIS Section, AIEE, held its Annual Election Dinner June 10 at the Memphis, Tenn., Athletic Club. Following the dinner, the new officers were announced and then installed for the 1960-61 term of office by Prof. Walter Criley, vice-president elect of District 13. Shown are: (*left to right*) Milton Parnell and Ben Kaufman, directors; Prof. Criley; Jim Fletcher, chairman; L. E. Cox, Jr., vice-chairman; and J. A. Blackburn, treasurer. Those not present were: Brother Lawrence Philip, secretary; and J. C. Jenkins, director. Directors retained from last year were: L. B. Allen, J. J. McCullough, and M. B. Stephenson. Among the guests present were: J. H. White, 1960-61 chairman of the Jackson, Tenn., Subsection, and T. A. Fail, past chairman of the Subsection, and their wives.

Recognition Awards Committee Names Recipients of Five Awards

The AIEE Recognition Awards Committee of which S. R. Warren, Jr., is chairman, announces the recipients of the four awards to be made at the Fall General Meeting in Chicago, Ill., on October 10, 1960. The Mervin J. Kelly Award will be made at the 1961 Winter Meeting.

The Medal in Electrical Engineering Education—to Ernst Weber.

The William M. Habirshaw Award in Transmission and Distribution—to S. B. Crary.

Conference Papers Open for Discussion

Conference papers listed below have been accepted by AIEE *Transactions* and are now open for written discussion until August 29. Duplicate double-spaced typewritten copies of each discussion should be sent to E. C. Day, Assistant Secretary for Technical Papers, AIEE, 33 W. 39th St., New York 18, N. Y., on or before August 29.

58-1362 **A Digital Nuclear Reactor Control System.** *E. P. Gyftopoulos, P. M. Coble*

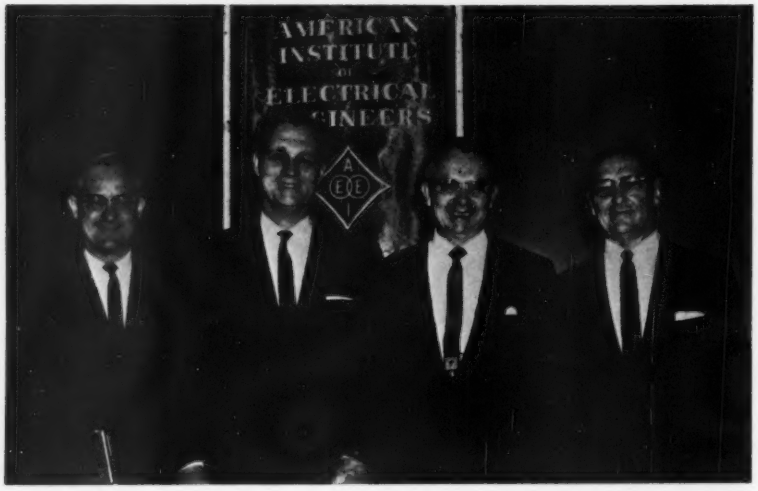
59-160 **A Transistor Oscillator Limit Switch for Indicating and Recording Instruments.** *J. T. Wintermute, S. G. Hayter*

60-23 **Economic Trends Make Railroad Electrification Inevitable.** *L. B. Curtis*

60-601 **Air-Cleaning Features for Traction Equipment.** *P. G. Lessmann*

Preprints may be purchased at 50¢ each to members, $1.00 to nonmembers, if accompanied by remittance or coupons. Please order by number and send remittance to: AIEE Order Department, 33 W. 39th St., New York 18, N. Y.

New Officers Named



OFFICERS for the 1960-61 year were elected at a recent meeting of the Cleveland Section, AIEE, as follows: (*left to right*) Secretary J. C. Ponstingl, Westinghouse Electric Corporation; Chairman A. J. Hornfeck, Bailey Meter Company; Treasurer J. J. Tesar, Cleveland Electric Illuminating Company; and Vice-Chairman L. J. Shaffer, Ohio Bell Telephone Company.

The Mervin J. Kelly Award in Telecommunication—to M. J. Kelly.

The Morris E. Leeds Award in Instrumentation—to Perry Borden.

The David Sarnoff Award in Electronics—to Rudolf Komplner.

Biographical outlines and photographs will appear in the September issue of *Electrical Engineering*.

Fellowship Awarded in Electrical Engineering

The American Society for Engineering Education (ASEE) has announced the award of a Leeds & Northrup Foundation Fellowship in electrical engineering to W. D. Stanley of Bladenboro, N.C.

Mr. Stanley is a graduate in electrical engineering at the University of South Carolina and will work for his Ph.D. degree at North Carolina State College. He holds the Physics Award of Sigma Pi Sigma professional physics fraternity, and has been a chapter officer of Tau Beta Pi engineering fraternity and of Pi Mu Epsilon mathematics fraternity. He is also a member of Phi Beta Kappa. He has been vice-chairman of student chapters of the AIEE and the Institute of Radio Engineers. He was given the University of South Carolina award as outstanding senior in electrical engineering, and has held a Westinghouse achievement scholarship, a Norman Murray Smith scholarship, and a Rion honorary scholarship in mathematics, and has been a technician and chief engineer at Stations WUSC-FM and WMSC.

The ASEE also announced renewal of a Leeds & Northrup Fellowship to C. G. Smith, for his third graduate year at Princeton, and to R. G. Marsh for his second graduate year at Washington University.

Leeds & Northrup Fellowships were established 5 years ago to help support the advanced education of outstanding young engineers. Each award pays $3,000 a year, divided between student and institution.

8th EJCC To Be Held December 13-15 in New York

The 10th annual Eastern Joint Computer Conference (EJCC) will be held December 13-15 at the Hotel New Yorker and Manhattan Center in New York, it has been announced by Nathaniel Rochester of International Business Machines Corporation, general chairman of the conference.

Mr. Rochester said abstracts of technical papers proposed for the conference should be submitted by August 13 to the technical program chairman, E. C. Kubie, Computer Usage Company, Inc., 18 E. 41st St., New York 17, N. Y. Subject matter of the proposed papers should concern recent achievements or techniques in the design and use of computing equipment.

"In an attempt to build a program of the highest possible quality, no parallel sessions are planned and a $300 prize will be awarded for the best presentation of a paper at the conference," Mr. Rochester revealed.

The EJCC is sponsored by the National Joint Computer Committee which consists of representatives of the AIEE, the Institute of Radio Engineers, and the Association for Computing Machinery. The committee sponsors two meetings each year, one on the East, and the other on the West Coast. More than 2,500 members attended the 1960 Western Joint Computer Conference in San Francisco this May. The 1960 EJCC will be the committee's 8th semiannual conference.

In addition to Mr. Rochester and Mr. Kubie, members of the General Committee for the December meeting include: Publication chairman, C. J. Rachel, Remington Rand Division of Sperry Rand Corporation; Local Arrangements Committee, B. W. Leavitt and A. L. Brown, General Telephone & Electronics Laboratories; Finance, A. I. Schott, National Cash Register Company; Hotel, W. W. Ward, International Business Machines Corporation; Publicity and Printing, J. W. Heaney, Jr., and J. J. Lanigan, Sylvania Electric Products Inc.; Registration, Jack Behr, Packard Bell Computer Corporation; Hospitality, R. P. Fopeano, Bendix Computer Division of Bendix Aviation Corporation; Exhibits, A. D. Meacham, Consultants to Industry Inc.; and Exhibits Management, John Leslie Whitlock Associates.

AIEE FELLOWS ELECTED

***Hans Paul Kuehni** (AM '29, M '43), consultant, General Engineering Laboratory, General Electric Company, Schenectady, N.Y., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to measuring and recording techniques for electrical and physical quantities." Mr. Kuehni was born June 16, 1895, in the City of Biel, in Bern, Switzerland. In 1920, he received a diploma in electrical engineering from the Swiss Federal Institute of Technology in Zurich. Eleven years later, he obtained the M.S. degree in electrical engineering from Union College in Schenectady, N. Y. His early professional engineering work was with the Bernese Power Company in Switzerland. This work included the design and construction of high-voltage transmission lines in the Swiss Alps and from Switzerland to France. Upon his arrival in the United States in 1923, he joined General Electric as a development engineer in the General Engineering Laboratory in Schenectady. As a member of the high-voltage laboratory founded by Charles P. Steinmetz, Mr. Kuehni concerned himself with high-voltage transient phenomena on transmission lines, techniques for the measurement of voltages and currents of natural and artificial lightning, high-voltage impulse generators, high-speed cathode ray oscillography developments, standardization work of impulse test waves and lightning protection of transmission lines and of associated power ap-

*Mr. Kuehni's transfer to the grade of Fellow was approved at the Board of Directors meeting on April 25, 1960.

H. P. Kuehni

paratus. As project engineer, he was in charge of the development, design, and construction of large network and mechanical differential analyzers partly for General Electric use and for sale. In 1938, Mr. Kuehni was appointed manager of the General Engineering Laboratory's Mechanical Division, a position he held for 14 years. He provided the technical direction in such areas as electric gaging, transducers and associated oscillograph equipments, electric template follower controls for machine tools, photoelectric line follower systems to machine parts directly from drawings. Mr. Kuehni was appointed consultant of the General Engineering Laboratory in 1953, with broad responsibility to provide 2-way technical coupling between the Laboratory and assigned General Electric Operating Departments and also technical consulting. Mr. Kuehni is a registered professional engineer in the State of New York.

AIEE PERSONALITIES

J. F. Bartholomew (AM '49) has been appointed sales manager of the Equipment Division of EPSCO, Inc., Cambridge, Mass. He was formerly district manager of the New York office of Consolidated Electrodynamics Corporation.

O. P. Cleaver (AM '36, M '48) recently received his 8th "outstanding" rating in recognition of his work as chief of the electrical engineering department at the U. S. Army Engineer Research and Development Laboratories, Fort Belvoir, Va.

H. L. Garbarino (AM '50, M '58) has been appointed vice-president and technical director of *Industrial Research* magazine, published by Scientific Research Publishing Company, Chicago, Ill. Mr. Garbarino was formerly chief engineer at Magnaflux Corporation, a subsidiary of General Mills.

W. C. Gardiner (M '55), manager, electrochemicals section, development department, Chemicals Division, of Olin Mathieson Chemical Corporation, has prepared a 2,500-word survey article on industrial electrochemical process and a 200-word article on nitrogen fixation for the McGraw-Hill Encyclopedia of Science and Technology. Both articles are based largely on Dr. Gardiner's experiences during 28 years with Olin Mathieson, including his work at the company's Niagara Falls facility.

L. R. Gaty (AM '39, F '50), vice-president, research and development, of Philadelphia Electric Company, Philadelphia, Pa., has been elected president of nuclear group, High Temperature Reactor Development Associates. Mr. Gaty has served on the following AIEE Committees: Management (1953-58, chairman 1955-58); Research (1955-60); and Publications Department (1957-60), chairman (1957-58).

G. A. Goetz (AM '53, M '56) has received an Award of Merit from the Engineers Club of Trenton, N. J., for valuable service in bringing high honor to his profession. The citation, which concerned the working out of his affliction of multiple sclerosis, stated: ". . . by his great courage and resourcefulness in meeting severe physical limitations, he has set an example worthy of all of us to follow."

F. L. Gosnell (AM '48) has been appointed sales manager of the Wang Laboratories, Inc., Natick, Mass. Before joining Wang, Mr. Gosnell was senior sales engineer in the Boston, Mass., office of Weston Instruments.

J. M. Harrer (M '40), veteran member of the Argonne National Laboratory's Reactor Engineering Division, has transferred to the staff of the Particle Accelerator Division to assist the division director with design co-ordination and operational problems relative to the Zero Gradient Synchrotron. Mr. Harrer has served on the AIEE Nucleonic and Radiation Instruments Committee (1957-60) and Nucleonics Committee (1958-60).

R. W. Hodgers, Jr. (AM '54) has been named manager of engineering for the X-ray department of General Electric Company, Milwaukee, Wis. He succeeds **M. A. Edwards** (M '40, F '47), who has been transferred to Schenectady, N. Y., as manager, advanced product planning, Electronics Component Division. Mr. Hodgers joined General Electric in 1943. Mr. Edwards has served on the AIEE Nucleonic and Radiation Instrumentation Committee (1958-60).

J. V. L. Hogan (AM '11, F '54, Member for Life), president in charge of engineering of Hogan Laboratories, Inc., has been appointed to the Board of Directors of the TELautograph Corporation, which acquired the Laboratories in August 1959.

G. L. Hollander (AM '50, M '56) has been named manager of the newly formed general-purpose computer department at Hughes Aircraft Company's ground systems group in Fullerton, Calif. Mr. Hollander joined Hughes in April from the Philco Corporation in Philadelphia, Pa. He has served on the AIEE Computing Devices Committee (1958-60).

W. R. Hough (AM '35, F '48), since 1948 vice-president of engineering for the Reliance Electric and Engineering Company, Cleveland, Ohio, has been assigned to a new executive position in the company as vice-president of research, development, and engineering. He has served on the AIEE Sections Committee (1945-56, chairman 1953-55) and Rotating Machinery Committee (1947-55, chairman 1953-55).

J. H. Hutchings (AM '36, M '43) has been named to the Board of Directors of Eitel-McCullough, Inc., manufacturer of Eimac electron-power tubes. Mr. Hutchings is president of National Electronics, Inc., Geneva, Ill., a wholly owned subsidiary of Eimac.

T. L. Jackson (M '41) has been ordered to the staff of the Chief Naval Air Training Center at the U. S. Naval Air Station, Pensacola, Fla. Captain Jackson previously served as director of base development in the Logistics Division on the staff of the North Atlantic Treaty Organization's Supreme Allied Commander Atlantic in Norfolk, Va.

W. M. Johnson (AM '46) has been appointed manager of the utility section of the Allis-Chalmers Manufacturing Company's St. Louis, Mo., district. Mr. Johnson joined Allis-Chalmers in 1945.

Leith Johnston (AM '54) has been appointed director of the newly created industrial systems development department of Automatic Electric Laboratories, subsidiary of General Telephone & Electronics at Northlake, Ill. Since joining the laboratories organization in 1927, his principal assignments have been in design work on totalizator and stock quotation boards, and development of fully automatic teletypewriter systems for the U. S. Army Signal Corps.

E. J. Kleine (AM '59) has been assigned as an application engineer to the regulator department of Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

E. J. M. Knitel (M '59), formerly employed as staff engineer with the Shawinigan Water and Power Company, Montreal, Que., Canada, has been appointed technical executive officer of the Canadian Overseas Telecommunication Corporation, Montreal.

R. E. Kuehn (AM '42, M '57) has been granted a 1-year leave of absence from the Owego, N. Y., facility of the International Business Machines' Federal Systems Division to serve with the Institute of Defense Analysis in Washington, D. C.

W. E. Lingar (AM '58), formerly with the Knoxville Utilities Board, Knoxville, Tenn., has recently been appointed to the staff of the Oak Ridge National Laboratory, Oak Ridge, Tenn., an atomic energy installation operated by the Union

Carbide Nuclear Company, a division of Union Carbide Corporation.

Coleman London (M '49) has been elected executive vice-president of Mosler Research Products, Inc., Danbury, Conn.

E. A. Martin (AM '56), assistant professor of nuclear and of electrical engineering at the University of Michigan, has been awarded the first Class of 1938 Engineering Distinguished Service Award. The award consists of a citation and $1,000.

Raymond Martin (AM '55) has been named chief engineer, distribution and transmission hardware, of the A. B. Chance Company, Centralia, Mo. Mr. Martin was previously a regional engineer for the A. B. Chance Company for 15 months.

M. J. McDonough (AM '59) has been promoted to regional electric utility and industrial products manager of Westinghouse Electric Corporation, Pittsburgh, Pa. He joined the Westinghouse Graduate Student Training Course in 1946, and since then has held several electric utility sales assignments.

H. F. Mitchell, Jr. (M '56) has been appointed a regional systems sales manager for Datamatic Division of Minneapolis-Honeywell Regulator Company, headquartered in the New York sales offices. Mr. Mitchell was formerly associated with the Eckert-Mauchly Computer Corporation, which has been absorbed by Sperry Rand.

L. J. Money (AM '43, M '53) has been appointed laboratory manager of tactical aircraft systems at Hughes Aircraft Company, Culver City, Calif.

Hideo Mori (AM '53) has been appointed vice-president of Hydel, Inc., Waltham, Mass. Mr. Mori was formerly technical aide to the director of the Dynamic Analysis and Control Laboratory at the Massachusetts Institute of Technology.

M. A. Moscarello (AM '52) has been appointed to the position of chief engineer for the Ford Instrument Company, division of Sperry Rand Corporation. Mr. Moscarello was assistant chief engineer for the last 2 years.

F. S. Oliver (AM '36, M '59) has joined the staff of the Electrical Research Laboratory at the Phelps Dodge Copper Products Corporation in Yonkers, N. Y. Mr. Oliver was formerly manager of research for the Doble Engineering Company, Belmont, Mass. He has served on the AIEE Special Instruments and Auxiliary Apparatus Committee (1956-60).

D. G. Paterson (AM '59) has been appointed applications engineering manager, Sperry Semiconductor Division, Sperry Rand Corporation, South Norwalk, Conn. Mr. Paterson came to Sperry Semiconductor this year from Motorola.

E. L. Peterson (AM '52, M '59), currently leader of an Optimum Systems Synthesis Project in the Technical Military Planning Operation, defense systems department, General Electric Company, Santa Barbara, Calif., is one of three General Electric employees who represented the United States at the First International Congress on Automatic Control at Moscow, Russia, from June 25 to July 8, 1960. Mr. Peterson presented a paper titled "Optimization of Multi-Output Time-Varying Systems with Multiple Nonstationary Inputs." He has served on the AIEE Feedback Control Systems Committee (1959-60).

C. B. Pickering (AM '46) has been appointed product manager of numerical control systems for Diehl Manufacturing Company, Somerville, N. J., a subsidiary of the Singer Manufacturing Company.

E. R. Piore (M '55) has been elected vice-president for research and engineering of International Business Machines Corporation (IBM), New York. Dr. Piore continues as IBM's director of research and in his new position exercises staff supervision over the company's research and engineering activities. He joined IBM in 1956. Dr. Piore serves on the AIEE Edison Medal Committee (1958-63).

D. J. Povejsil (AM '49) has been named director of new product services for Westinghouse Electric Corporation, Pittsburgh, Pa. He comes to his new post from the position of manager of systems planning at the Westinghouse research laboratories, a position which he held for the last year. Mr. Povejsil is the author of "Airborne Radar," a book scheduled for publication in the Fall.

Simon Ramo (AM '40, F '51), executive vice-president of Thompson Ramo Wooldridge, Inc., received an honorary doctor of engineering degree from the Case Institute of Technology at Case's 84th commencement in June.

Julian Rogoff (M '48), vice-president and manager of the Omaton Division of Burndy Corporation, has been elected executive vice-president of the corporation. Mr. Rogoff joined the company in 1930, and has been a member of the Burndy Board of Directors since 1947. Named to succeed Mr. Rogoff as manager of the Omaton Division, is **Fred Heller** (AM '49, M '56), formerly assistant manager. Mr. Heller joined Burndy in 1948.

C. V. Roseberry (AM '47, M '51), Westinghouse Electric Corporation vice-president in charge of the Midwestern region, has been awarded the Order of Merit, the company's highest honor for its employees. He was cited for: "His remarkable ability to develop customer confidence, particularly in the electric utility field, and for his executive leadership in the Midwestern region; for his outstanding contribution to company progress through the organization of its commercial atomic power activities, and for his co-operation with others in all departments of Westinghouse, particularly his inspired guidance to young men just beginning their careers."

V. W. Ruskin (AM '53) is a member of a new consulting engineering company called "Crippin Ruskin & Associates Engineering Ltd.," in Vancouver, British Columbia, Canada. He recently resigned from the position of director of planning of the British Columbia Engineering Company, Ltd., Vancouver. He has served on the AIEE Power Generation Committee (1958-60).

T. C. Sargent (AM '59) has been appointed manager of commercial engineering of Sylvania Lighting Products, a division of Sylvania Electric Products Inc., which is a subsidiary of General Telephone & Electronics Corporation, New York, N. Y. Since 1948, Mr. Sargent has had responsibility in commercial engineering for fluorescent and special lamp commercial liaison.

S. A. Schelkunoff (M '34, F '51), authority on the electromagnetic theory and antennas, has been appointed professor of electrical engineering at Columbia University. Dr. Schelkunoff will assume his duties at the university September 15. He has been an adjunct professor of electrical engineering at Columbia since 1958. He also holds the position of assistant vice-president of Bell Laboratories at Murray Hill, N. J.

H. H. Schenck (AM '39, M '47), until recently vice-president and director of engineering at Page Communications Engineers, Inc., a subsidiary of Northrop Corporation, Washington, D. C., has been named executive vice-president and general manager of the newly formed United States Underseas Cable Corporation.

R. A. Scholtz (AM '58), a systems analysis engineer in the Hughes Aircraft Company's airborne systems group, Culver City, Calif., has been selected for a Howard Hughes doctoral fellowship in science and engineering. He will go to Stanford University. Mr. Scholtz received the M.S. degree in electrical engineering in June at the University of Southern California under the Hughes master fellowship program.

R. L. Sell (AM '50), engineering executive for Telex, Inc., Minneapolis, Minn., has been named assistant vice-president of the electronics company. Mr. Sell continues as director of engineering, and in addition, has been given new responsibilities as director of sales and marketing for the company's components group, which includes special products, communications accessories division, and magnetics. Since he joined Telex a year ago, Mr. Sell has directed development of a number of advances in hearing aid design.

J. E. Shepherd (M'44) has been appointed manager of the Sperry Rand Corporation's Research Center, which is to be built this year in Sudbury, Mass. Dr.

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grade, qualifications, and fees may be obtained from Mr. N. S. Hibshman, Secretary, 33 West 39th Street, New York 18, N.Y.

Shepherd was formerly manager of the Electronic Tube Division, Sperry Gyroscope Company, Great Neck, N. Y., where he directed research, development, and production of microwave devices for radars and communications systems.

R. H. Smith (M '36), secretary, Reliance Electric & Engineering Company, has been appointed chairman of the Public Relations Committee of the National Electrical Manufacturers Association. Another member of the committee is **G. W. Griffin, Jr.** (AM '50), vice-president—public relations, General Telephone and Electronics Corporation.

A. H. Sonnenschein (AM '51, M '58) has been appointed director of planning, Polarad Electronics Corporation, Long Island City, N. Y. He joined the technical staff of Polarad in 1951 as a project engineer and was subsequently appointed group leader, director of engineering operations, and chief systems engineer.

Philip Sporn (AM '20, F '30, Member for Life), president of the American Electric Power Company, has been presented the annual Conservation Service Award of the U. S. Department of Interior. In a citation letter presented to Mr. Sporn, Secretary of the Interior F. A. Seaton stated that the award was "in recognition of the valuable services you have rendered as a proponent of conservation of the fuels of the United States." Mr. Sporn was an Edison Medalist in 1945, and has served on the AIEE Transmission and Distribution Committee (1927-47, chairman 1941-43) and Special Committee on the Use of Silver as Substitute for Copper and Aluminum in Electrical Installations (1943-44).

R. C. Stiles (AM '51, M '57), supervisor of electronic switching systems design and development for Automatic Electric Laboratories, Northlake, Ill., has been named to the staff of Lt. Gen. J. D. O'Connell, vice-president of General Telephone & Electronics Laboratories, Inc., Mountain View, Calif. Mr. Stiles joined Automatic Electric in 1945.

M. L. Stoughton (AM '43, M '49) has been named apparatus engineer for the Kelman Power Circuit Breaker Division of I-T-E Circuit Breaker Company, Los Angeles, Calif. He came to the West Coast division from Philadelphia, Pa., where he served during the last 11 years as manager of the I-T-E Philadelphia district office.

G. N. Thayer (M '57), vice-president—operations of the American Telephone and Telegraph Company, was awarded an honorary doctor of engineering degree at the June commencement exercises of the Stevens Institute of Technology. Mr. Thayer has also been named to the Stevens' Board of Trustees. He is a 1930 graduate of Stevens.

At the recent 32nd annual conference and exhibit of the Petroleum Industry Electrical Association (PIEA) in Kansas City, Mo., **J. D. Trilsch** (AM '57) of Trilsch Corporation, Houston, Texas, was elected president of the Petroleum Electric Supply Association (PESA), the suppliers group affiliate. **F. S. Jones** (AM '56) of Platte Pipe Line Company, Kansas City, was named secretary-treasurer of PIEA. Named to the enlarged board of directors of PESA was **Pat King,** (AM '52), Westinghouse Electric Corporation, Dallas, Texas.

J. G. Truxal (AM '51, M '54), professor of electrical engineering and head of the department at the Polytechnic Institute of Brooklyn in New York, took part in an international engineering meeting sponsored by the International Federation of Automatic Control, held June 26-July 3 in Moscow, USSR. Dr. Truxal delivered an invited paper on "Approximate Identification of Process Dynamics in Computer Controlled Adaptive Systems." He has served on the following AIEE Committees: Feedback Control Systems (1956-60, chairman 1959-60); Automation and Data Processing (1958-60); Recognition Awards (1959-60); and Industry Division (1959-60).

C. K. Tubbs (AM '50) has been appointed manager of industrial sales, Pittsburgh, Pa., district, of the Allis-Chalmers Manufacturing Company. Mr. Tubbs was formerly sales representative in the Pittsburgh district.

B. M. Van Emden (AM '58) has been appointed chief research engineer of Automation Development Company, a subsidiary of Lerco Electronics, Inc., Los Angeles, Calif. Mr. Van Emden was formerly associated with Hydro-Aire Company.

E. A. Wagner (AM '96, F '27, Member for Life), former manager of the Pittsfield Works of the General Electric Company and now retired, received the Rollins College Medal of Honor on Honor Day in June. Mr. Wagner organized the Rollins College Sigma Xi Club and the Fort Wayne, Ind., Section, AIEE.

E. A. Walker (AM '34, F '47), president of the Pennsylvania State University, is the new president of the American Society for Engineering Education. His year's term of office began in July 1960. Mr. Walker has served on the following AIEE Committees: Education (1945-58, chairman 1956-58), and Charles LeGeyt Fortescue Fellowship (1952-55, chairman 1954-55). He is an AIEE representative to the Engineers' Council for Professional Development (1958-61).

The Public Welfare Medal of the National Academy of Sciences awarded for "eminence in the application of science to the public welfare" was presented to **A. T. Waterman** (M '48), director of the National Science Foundation, at the 97th annual meeting of the Academy in April.

D. D. Welt (AM '56) has been appointed product manager of reactor control systems in the Electronics Division of Stromberg-Carlson, which is a division of General Dynamics. Mr. Welt joined Stromberg-Carlson in 1957. **R. L. Deming** (M '59) has been named manager of Stromberg-Carlson's Nucleonics Systems Laboratory. Mr. Deming had been head of design and development groups for reactor controls since 1955, and has served on the AIEE Nucleonic and Radiation Instrumentation Committee (1959-60).

R. R. Wheeler (AM '54), recently with Moloney Electric and Westinghouse, and a specialist in high-voltage transformer design, has been appointed senior design engineer of Electro Engineering Works, San Leandro, Calif.

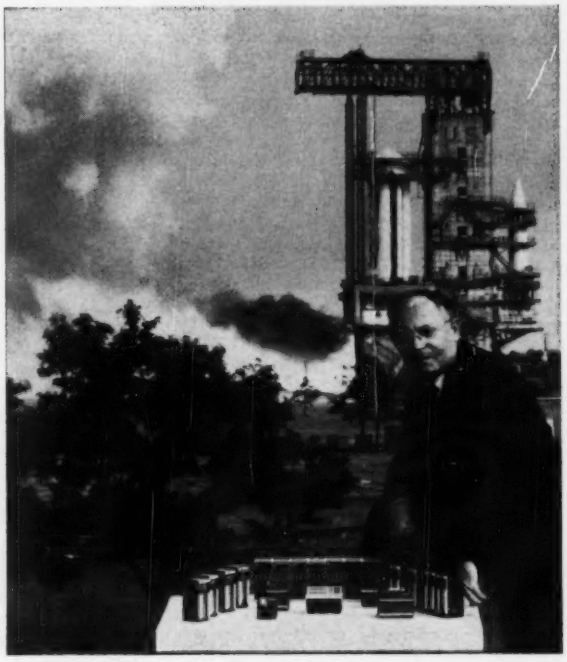
OBITUARIES

Fraser Jeffrey (AM '11, M '12, F '24, Member for Life), assistant chief electrical engineer with Allis-Chalmers Manufacturing Company, Milwaukee, Wis., until his retirement in 1952, died on March 24 at the age of 76. Mr. Jeffrey was born January 23, 1884, in Cobourg, Ont., Canada. In 1905, Mr. Jeffrey went to Cincinnati, Ohio, to work for the Bullock Electric Manufacturing Company. When this company was acquired by Allis-Chalmers in 1910, he moved to Milwaukee. He worked on the design of induction and synchronous motors and at one time was engineer-in-charge of induction motor design. Mr. Jeffrey served on the following AIEE Committees: Iron and Steel Industry (1920-21), Industrial and Domestic Power (1920-22), General Power Applications (1930-34), Transportation (1938-46), and Power Generation (1942-46).

Emile Isaac LaSere (AM '46), chief electrical designer, Northern States Power Company, Minneapolis, Minn., died recently. He was born June 1, 1906, in London, England. In 1927, he was employed by Northern States Power Company as a draftsman, and in 1936, was elevated to chief draftsman. During World War II, he taught drafting in the U. S. Navy Construction Battalion Training Center, where he served as chief electrician's mate. He later returned to the Northern States Power Company, and in 1946 was named chief electrical designer. His duties were the supervision of design and drafting of drawings pertaining to all construction projects of the company, including substations, transmission lines, and gas operations.

Frederic Bazin Wipperman (AM '20, Member for Life), retired executive vice-president of the National Industrial Service Association, Inc., St. Louis, Mo., died May 22. He was born January 6, 1892, in Logansport, Ind. Mr. Wipperman studied electrical engineering at Cornell University. He worked for the Ohio Invector Company and the Wagner Electric Corporation until World War I, when he served overseas as a captain in the Army Corps of Engineers. He became the first full-time executive vice-president of the National Industrial Service Association in 1948 after serving the association in a part-time capacity for 5 years. He is a member of Tau Beta Pi, Eta Kappa Nu, and a past chairman of the St. Louis Section, AIEE.

OF CURRENT INTEREST



AGAINST flame and roar of Saturn's huge 30-million-hp super-booster is the scientist who directs computation of test-firing results, Dr. Helmut Hoelzer, with a model of the new IBM *7090* computer that will enable his space-team associates to explore new areas of rocket engine research. Dr. Hoelzer is director of the Computation Division at Marshall Space Flight Center, Huntsville, Ala., where this test of Saturn's 8-engine super-booster took place recently. IBM *7090* will apply the most powerful computing ability in the United States space program to analysis of rocket vibration, heat transfer, and dozens of other elements.

U.S. Space Probers Get Powerful New Computer

A COMPUTER, said to be the most powerful to be used in America's space program, was put to work recently on Project Saturn.

The computer will be a key design and development tool in building the free world's biggest space vehicle, according to Dr. Wernher von Braun. The IBM *7090* data-processing system will be used by space scientists at Huntsville, Ala., to help meet the Saturn super-booster's critical timetable.

Dr. von Braun is director of the Development of Operations Division, Army Ballistic Missile Agency, AOMC. On July 1, the division formally became the George C. Marshall Space Flight Center of the National Aeronautics and Space Administration.

PERFORMANCE of Saturn—which will send multiton payloads into earth orbit; around the moon and back; and into deep space—will be polished while the huge vehicle is on the ground. Saturn's 1,500,000-pound-thrust booster will be mathematically "flown" thousands of times within the *7090* before reaching the launching pad next year, with each flight taking only a few minutes. Here, Dr. von Braun (*right*), reviews solar-system flight calculation with Dr. Hoelzer (*left*), and Dr. Eberhard Rees, deputy director for research and development, at Marshall Space Flight Center.

The Saturn vehicle is being built to send multiton payloads into earth orbit; around the moon and back; and into deep space. In the course of development work, the new solid-state computer is expected to achieve the most accurate and detailed trajectory simulations ever plotted.

Saturn's 1,500,000-pound-thrust booster will be "flown" thousands of times within the *7090* before being placed on a launching pad next year. With the new equipment, Marshall Space Flight Center personnel will see within a few minutes how their design modificatons would affect an actual flight into space.

At a dedication ceremony, during which the electronic system was formally turned over to the center's Computation Division, Dr. von Braun said: "In a decade computers have developed from a curiosity and convenience in space vehicle design to an integral, indispensable element of our work.

"In 1951," he said "we worked on the 200-mile Redstone ballistic missile using a computer which could add only 2,174 numbers a minute. Today we are working on the Saturn vehicle designed for deep space probes. We have an urgent need for the power of the *7090*, which can add 13,740,000 numbers per minute."

The Marshall Space Flight Center's *7090* computer is the first of its type to be installed by International Business Machines Corporation (IBM) for scientific or commercial data processing. Modified versons of the system are being incorporated into the Ballistic Missile Early Warning System.

It was planned to install a second *7090* in the Computation Division in July. Al-

though the two solid-state computers will replace three large-scale vacuum tube machines, they will more than triple the computing capacity available to Project Saturn scientists and engineers.

New Dimension Added to Space Research

The increased computing ability will help the Marshall Space Flight Center explore new areas of research opened by the clustering of eight powerful rocket engines in the Saturn booster. Measurements made as the booster generates up to 30 million hp in static firing tests will be fed into the IBM *7090* to analyze vibration and heat transfer caused by interaction of the engines. Fuel slosh in the booster's multiple tanks also will be under study.

A major research effort utilizing the *7090* capabilities will examine the problems of multiplexing the Saturn's fuel supplies. If one or more engines should fail, the fuel would be redirected to other engines to enable the vehicle to continue its mission. Using the computer, Dr. von Braun's group will determine the best way to do this at various stages of flight under varying conditions of flame-out.

Dr. Helmut Hoelzer, director of the Computation Division, and C. L. Bradshaw, deputy director, reported that because of Saturn's size and complexity, the amount of information obtained from each static firing test for computer analysis is eight to ten times greater than in any previous space program. They said evaluation of telemetering data for a live flight of the single-engine Redstone took as long as 5 to 6 weeks. It is expected the center's new *7090*s will do the same job for the Saturn in 3 or 4 days.

The *7090* is able to reduce the millions of pieces of information gathered from test firings into meaningful form quickly because of its operating speed. It is able to call information from its magnetic core storage unit in 2.18 millionths of a second. With the use of a new data multiplexer, the system simultaneously is able to read information from magnetic tape, write information on tape, and compute.

"SPOOK"

To take full advantage of the computer's operating speed, the Marshall Space Flight Center Computation Division has devised an automatic system which enables the *7090* to monitor its own operations. It is called SPOOK—Supervisory Program Over Other Kinds—and represents an unseen hand telling the computer what to do at the right time to do it.

SPOOK consists of one reel of magnetic tape containing 50,000 instructions. As different types of work are processed, the computer will tell its operator what is being done and when tape reels must be changed.

There will be relatively few live tests of Saturn because of the vehicle's cost. Dr. Hoelzer, who has worked with Dr. von Braun in the field of rocketry and space flight for more than 20 years, said: "The V-2 rocket was developed at Peenemunde basically without automatic digital computers. As a result, there were approximately 1,000 test firings. Yet with the vastly more intricate Saturn, we have scheduled only 10 research and development firings.

"We now can simulate a trajectory in a few minutes on the *7090* for several hundred dollars. It would cost millions of dollars to stage a live flight. Yet, by repeated flight simulation we can find out much of the information we would obtain from a launching."

To simulate Saturn flights, mathematical equations representing factors such as weather conditions and the rotation and gravitation of the earth and moon are stored within the *7090*. Information about the design of the booster then is fed into the computer so that it can determine the trajectory the vehicle would take.

In addition to providing development assistance, the new systems also will have a direct effect on Project Saturn's computation costs. Dr. Hoelzer said the two *7090* systems will accomplish in 8 hours what three large-scale vacuum tube machines accomplished in 20 hours. He said they will do this with a 25% saving in machine time costs and a corresponding decrease in personnel time. **EE**

Fuel Cell Power Pack Developed for Military Use

A PORTABLE power supply representing one of the first practical military applications of fuel cells—devices that convert chemical energy directly to electricity—is being developed by General Electric Company (GE).

Because it is being designed to have the ruggedness and dependability of standard battlefield hardware, the unique power-making package is a major step in the growth of fuel cells as practical energy sources, according to W. C. O'Connell, general manager of the company's aircraft accessory turbine department which is developing the unit.

He explained that although fuel cells of various types have been made and demonstrated under experimental circumstances, GE's program is the first aimed at building a fuel cell power source that can be mass produced and made available to the military as an off-the-shelf item.

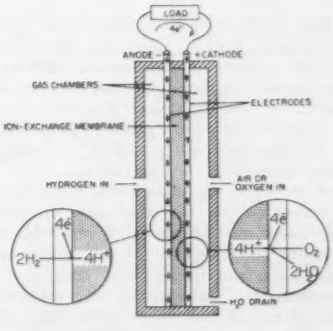
The unit is being developed for the Electronics Division of the U.S. Navy's Bureau of Ships and the Radar Division of the U. S. Army Signal Corps to supply power for a Marine Corps and Army portable field radar set.

Easily Carried

Producing 200 watts of 24-volt direct current for 14 hours, the 30-pound power pack can be carried easily by one man and will take the place of a 55-pound engine generator or 80 pounds of secondary batteries. If operated continuously over longer periods of time, it requires only additional increments of fuel. For example, to provide full power at a remote site for a week, only 72 pounds of fuel would be needed. This is opposed to transporting almost ½ ton of freshly charged batteries to the site.

The power pack is designed to operate at full load for a minimum of 2,000 hours without maintenance. However, a much longer life is expected since experimental fuel cells have been operating continuously for more than a year, it was pointed out.

Heart of the unit is a series of 30 ion-membrane fuel cells whose basic concept was developed by the company's Research Laboratory. Each cell will be an 11-inch square assembly approximately ¼ inch thick. Consuming only oxygen from the air and hydrogen produced by the decomposition of a metal hydride "fuel," an individual cell is silent, odorless, has no moving parts, operates at negligible internal pressure and temperature, requires no complex control system, and utilizes a solid electrolyte rather than a caustic liquid. When large banks of cells or modules are packaged together, a small



CHEMICAL REACTIONS

ANODE	OVERALL	CATHODE
$2H_2 - 4H^+ + 4e^-$	$2H_2 + O_2 \rightarrow 2H_2O$	$4e^- + 4H^+ + O_2 \rightarrow 2H_2O$

HYDROGEN and oxygen are supplied from outside the cell at ambient temperature and pressure. The gases enter opposite sides of the cell and are separated by a plastic membrane. Electrodes are in contact with the surface of the membrane-electrolyte. At the anode: hydrogen ionizes and the electrons that are given up in forming the ions are collected in the electrode, conducted to the load and do work. The ions are conducted through the membrane (solid electrolyte) to the cathode. At the cathode: oxygen reacts with the electrons that have traveled through the external circuit and the ions that have traveled through the membrane. Over-all result: the controlled chemical combining of hydrogen and oxygen to form water, and the release of useful electric energy.

MODEL AE-12 fuel cell power pack being developed by GE for the Marine Corps and Army Signal Corps will weigh 30 pounds and will be easily handled by one man. About the size of a suitcase, it will be carried by hand or on a standard MK VIII pack board. As a power source for field radar, the operating unit (shown at left in mock up) will produce 200 watts of direct current at 24 volts. Replaceable canisters inside perforated guard at top produce fuel for 14 hours unattended operation. Corner of casing is cut away to show arrangement of individual fuel cells within power pack. Artist's conception (*right*) illustrates how fuel cell power pack will be used to produce electricity close to enemy lines.

fan is often used to improve air circulation within the fuel cell system.

The power pack can be refueled with no interruption in operation. The metal hybride is contained in reusable, hermetically sealed canisters which are "plugged" into the power pack. Each canister, containing approximately 6 pounds of fuel, keeps the unit going for 14 hours at full load.

These performance characteristics and the power pack's inherent mobility, mounted either on a standard military pack board or carried by hand, make it ideal as an energy source for electronic gear used in the assault phase of amphibious landings and other rapidly changing tactical situations, it was stated.

For example, its few moving parts suit the power supply for front line surveillance situations where there must be a minimum of detectable noise, audio or radio. This, and the greatly reduced requirements for maintenance and replacement parts, are the major advantages of fuel cells over engine generator sets.

Since it must withstand the extremes of environmental conditions encountered by military field forces all over the world, the unit is being designed to operate on wind-swept beaches, in tropical rainstorms, on hot sunny days, or covered with a half inch of frost.

Electrolyte

The electrolyte of the GE fuel cell is a special plastic membrane having a metallic electrode in contact with each of its sides. In operation, hydrogen released by the decomposition of the metal hydride "fuel" contacts one side of the sheet of plastic, oxygen in the air contacts the other side. At one of the electrodes the hydrogen breaks up into electrons and positively charged hydrogen ions. The electrons travel through an external circuit from one electrode to the other, thus creating one half of an electric circuit. The positively charged hydrogen ions move through the membrane to the other electrode where they combine with the oxygen to form water and complete the circuit. **EE**

"Cocktail Party Effect" Reproduced Electronically

The psychoacoustic phenomenon called the "Cocktail Party Effect" was recently duplicated electronically by a group of investigators at Bell Telephone Laboratories. This term has been applied to the ability of the human listener to concentrate on a specific voice in which he is interested, and thereby separate it from the surrounding babble of voices or other noise, even though it may be no louder than the surrounding noise level.

The binaural, or 2-eared, listener is able to enhance the effective intensity of the desired voice by 5 to 15 db by suppressing the background noise level. A scheme for reproducing this feat electronically was recently described by E. E. David, Jr., and J. F. Kaiser of Bell Laboratories to the Acoustical Society of America, meeting in Providence, R. I.

In the cocktail party effect, the disparate sound-waves picked up by the two ears are used. The single ear, with only one sample of the sound field, cannot pick out specific voices or sounds from a surrounding babble as easily. A telephone transmitter, or any single microphone, is similarly unable to suppress spurious noises. Thus, background noise interferes much more with the voice of a person talking over a telephone or loudspeaker system than the same noise would if the 2-eared listener were standing in the same room as the talker.

The gain achieved by the ear and brain in the cocktail party effect is greater than would be expected through simple linear addition of the two aural inputs. Therefore, nonlinear techniques were used in the attempts to duplicate the effect electronically. In one technique, the outputs of two microphones were compared, or cross-correlated, to generate a "gating wave" which was then applied to the combined output of the two microphones. The effect of this gating was to raise the intensity of the combined signal only when energy from the desired voice arrived simultaneously at both microphones. Otherwise, the gate suppressed the combined signal. Noise or interfering speech signals passed through the gate if they occurred simultaneously with the desired speech signal. However, these events were rare and the pattern, or continuity, of the undesired signal was disrupted. Thus, its interfering qualities were greatly reduced.

In subjective tests with such a processor using preliminary circuit concepts, enhancements of 9 db in effective signal levels were achieved against an interfering single-talker background. A smaller effect, 5 db, was found when two extra talkers interfered.

While the data reported are the results of early experiments, they indicate that machine reproduction of some elementary properties of human hearing may not be as far in the future as previously expected. **EE**

Use of Television Images in Fluoroscopic Diagnosis

A physician reported recently on advances in techniques for making X-ray fluoroscopic examinations with reduced amounts of radiation—and in such a way that entire teams of consulting doctors or medical students can view the diagnostic X-ray images on the screen of a device resembling a console-model television set.

Even the patient can watch his own examination if he wishes.

R. H. Morgan, M.D., professor of radiology at The Johns Hopkins University in Baltimore, Md., described the application of television instrumentation to fluoroscopic "image intensification," whereby X rays are converted into greatly intensified light rays before striking the fluoroscopic screen under view.

The radiologist spoke at the second of a series of X ray forums sponsored by the American College of Radiology.

"The application of television methods to fluoroscopy allow a number of innovations in technique which are likely to provide the radiologist considerably more freedom in the design and use of his apparatus in the years to come. Improvements include use of the fluoroscope in normal daylight, improved rendition of radiologic images, both in terms of detail and contrast, and cinefluorography (X ray motion pictures) at extremely low dosage values," Dr. Morgan states.

"Television techniques also make possible the complete separation of the viewing screen from the radiation beam. As a result, fluoroscopes have now been designed with the X ray tube located over the table (on which the patient lies) as in radiography (making of X ray films), rather than under the table as heretofore. When over the table, the X ray tube need no longer be close to the patient with attendant image distortion and relatively high dose rates," he continued. Dr. Morgan said the new method can reasonably be expected to lower radiation dosage to the patient in gastrointestinal examinations by half, and in certain heart examinations by as much as 90%.

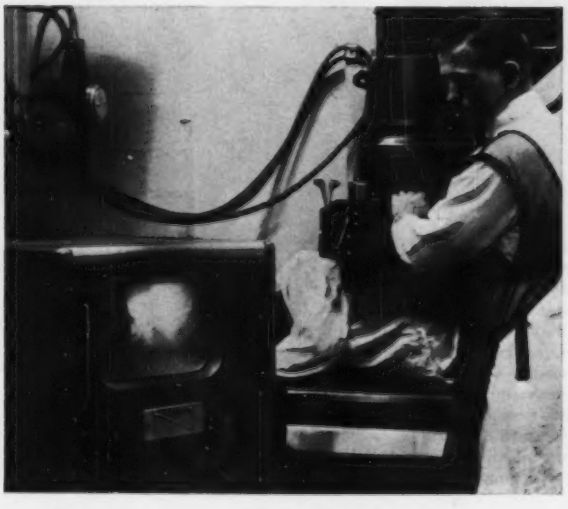
Television methods also permit the viewing of fluoroscopic images by many individuals rather than by a selected few. "This is proving to be of great value in such specialized fields as cardiac radiology, where the entire clinical team may see the fluoroscopic examination in detail. The use of television projectors for classroom teaching of students is another example where multiple viewing of fluoroscopy has been found advantageous," Dr. Morgan said. A convenience of the new system, to doctor and patient alike, is the saving of time—10 minutes at least—normally required for the fluoroscoping physician to adapt his eyes to a totally blacked out room. Images on the television monitor set now in use can be seen as well in a dim or normally lighted room as in the dark. This is comparable to the home viewing of television in a room with moderately subdued lighting, usually recommended as less of a strain on the eyes.

While the fluoroscopic examination is conducted, "spot" or instantaneous X ray films are made in the normal way to make a permanent record of the examination.

Four general categories were cited in which television systems for X ray image intensification have been investigated: (1) television systems optically coupled to conventional fluoroscopic screens, (2) "flying spot" television systems, (3) television systems optically coupled to electronic image tubes, (4) television systems with X ray sensitive detection tubes.

"The third television intensification system (the one in use at Johns Hopkins), that in which the television camera is optically coupled to an X ray sensitive electron image tube, is undoubtedly the system of greater interest in America at the present time. Television cameras which employ photosensitive detection tubes of either the image orthicon (television cameras based on a 'total' picture system) or vidicon types (television cameras based on a 'scanning' system of only certain portions of the subject) have been designed and are in use," Dr. Morgan pointed out. In the Johns Hopkins equipment, a zinc sulfide screen is used to convert X ray energy into light energy, greatly augmented.

"It is not known to what extent some of the applications of television fluoroscopy may be used in clinical radiology during the next few years," Dr. Morgan said. "One thing, however, is reasonably certain. Television methods in screen intensification permit sufficiently improved resolution and contrast perception and sufficiently greater flexibility of fluoroscopic equipment design and application, that such methods will find increasing use in all hospitals, large and small." EE



A PATIENT is examined by fluoroscope using new image intensifier method. Image seen on specially built television monitor set (left) is side view of abdomen of patient lying on table in background. X rays here converted into light rays, on television system coupled to electronic image tubes, are intensified 50,000 times. This enables the radiologist to make the fluoroscopic examination in a normally lighted room, yet at comparatively low exposure dosage.

Future Meetings of Other Societies

American Astronautical Society, Western National Meeting, Aug. 8-11, Olympic Hotel, Seattle, Wash.

International Electronic Circuit Packaging Symposium, Aug. 18-19, cosponsored by the University of Colorado and *Electrical Design News*, at the University campus, Boulder, Colo.

39th Annual Meeting of the National Council of State Boards of Engineering Examiners, Aug. 18-20, Hotel Multnomah, Portland, Ore., T. K. Legare, Palmetto State Life Bldg., P.O. Drawer 1404, Columbia, S.C.

Symposium on Thermonuclear Plasma Physics, Aug. 22-26, Gatlinburg, Tenn. sponsored by Oak Ridge National Laboratory and Oak Ridge Institute of Nuclear Studies in co-operation with the AEC. University Relations Division, ORINS, P.O. Box 117, Oak Ridge, Tenn.

IRE-WEMA, Western Electronic Show and Convention, Aug. 23-26, Memorial Sports Arena, Los Angeles, Calif. R. G. Leitner, WESCON Business Office, 1435 La Cienga Blvd., Los Angeles.

The Combustion Institute, 8th International Symposium on Combustion, Aug. 28-Sept. 2, California Institute of Technology, Pasadena, Calif.

Machine Tool Exposition, Sept. 6-16, International Amphitheatre, Chicago, Ill. National Machine Tool Builders' Association, 2139 Wisconsin Ave., N. W. Washington 7, D. C.

EIA, 2nd Conference on Value Engineering, Sept. 7-8, Disneyland Hotel, Anaheim, Calif. Electronic Industries Association, Engineering Department, 11 W. 42 St., New York 36, N. Y.

4th Annual Joint Military-Industrial Electronic Test Equipment Symposium, Sept. 14-15, Chicago, Ill., sponsored by the Office of the Director of Defense Research and Engineering and the Department of the Army Signal Corps. S. I. Cohn, Armour Research Foundation, 10 W. 35 St., Chicago.

ISA, 3rd Instrument-Automation Conference and Exhibit of 1960 and ISA's 15th Annual Meeting, Coliseum, New York, N. Y. Instrument Society of America, 313 Sixth Ave., Pittsburgh 22, Pa.

Overseas

IAEA Conferences

Medium and Small Power Reactors Conference, Sept. 5-9, Vienna, Austria. **Use of Radioisotopes in Physical Sciences and Industry Conference,** Sept. 6-17, Copenhagen, Denmark. International Atomic Energy Agency, Room 2249, United Nations Bldg., New York, N.Y.

UPADI, 7th Convention of the Pan American Federation of Engineering Societies, Sept. 12-16, Buenos Aires, Argentina, G. A. Hathaway, Engineers Joint Council, 29 W. 39th St., New York 18, N.Y.

5th International Instruments & Measurements Conference, Sept. 13-15, Stockholm, Sweden. Helge von Koch, Kungliga Tekniska Högskolan, Stockholm 70, Sweden.

8th Session of United Nations Scientific Committee on Effects of Atomic Radiation, Sept. 19-30, Geneva, Switzerland. United Nations Press Services, Office of Public Information, United Nations, New York, N.Y.

International Conference on Physics of Electrostatic Forces, Sept. 27-Oct. 1, Grenoble, France, Université de Grenoble, Institut Fourier, Place du Doyen-Gasse.

Industrial Latin American Partnership Exhibition, April 1960-Oct. 1961, Parque Ibirapuera, Sao Paulo, Brazil, E. I. Neville, ILAPE Representative, 60 E. 42 St., New York 17, N. Y.

The Power Behind the New "Voice" of Pioneer V Spacecraft

ANOTHER MILESTONE in space-to-earth communications was achieved when Radio Corporation of America (RCA) tubes powered the first radio signals of a new "voice" of the Pioneer V planetoid back to earth from a distance of 8,001,000 miles.

The transmission, made from the greatest distance over which man has ever received a radio broadcast, was powered by two identical electron tubes each about the size of a large spool of thread. Known as RCA developmental type *A-2629*, these 2-ounce ceramic-metal tubes measure 1¾ inches long and are slightly over 1 inch in diameter.

Seconds after these gold-plated tubes in the powerful 150-watt transmitter aboard the "paddlewheel planet" were "triggered" into operation for the first time, radio signals began carrying vital space data to the receiving station in Manchester, England.

The 150-watt transmitter is the most powerful radio ever sent aloft in an American deep-space probe. Previously, radio messages of the 94.8-pound space vehicle were originating from a 5-watt transmitter. Space scientists turned on the powerful new "voice" when signals from the smaller unit became weak.

"Successful transmission and reception over this incredible distance marks a giant advance in the science of interplanetary communications," said D. Y. Smith, vice-president and general manager, RCA Electron Tube Division.

"The RCA tubes within the instrument-crammed space scout will continue to power technical reports back to earth as the vehicle speeds on its 515-million-mile orbit around the sun. The electronic voice of Pioneer V is being received by the super-sensitive 250-foot 'radio dish' at the Jodrell Bank station in Manchester, England, and at the 60-foot 'radio dish' at South Point, Hawaii."

The space probe, launched from Cape Canaveral on March 11, has been gathering technical facts on the environment of deep space. Its transmitter, employing the small RCA tubes, radios information on the location and speed of the vehicle, its temperatures, as well as information about radiation and magnetic fields.

Other Tubes Issue "Commands"

Mr. Smith pointed out that three other RCA ceramic-metal tubes are performing vital control functions at each of the ground tracking and triggering stations in England and Hawaii.

These tubes are the "heart" of the signaling system which issues commands to the Pioneer V. Within this system, a small 2-ounce tube (RCA-*6816*) furnishes power to a 2-pound tube (RCA-*7213*) which in turn drives an 8½-pound developmental power tube (RCA Dev. type *A-2545*). The largest tube powers the transmission of instructions to the satellite.

Rocket Guidance System

It was also stated that when the paddlewheel satellite was blasted into outer space, two RCA tubes (RCA-*6816* and RCA-*7213*) were employed to help guide the Thor-Able IV rocket out of the atmosphere. These ceramic-metal tubes played a key role in the basic guidance system which started Pioneer V on its important trip.

Scientists of the National Aeronautics and Space Administration (NASA) feel that it is impossible to predict the useful life of Pioneer V's transmitter at this time. Depending on component lifetime, they state, the communications system may continue to function for many more millions of miles.

NASA Administrator, Dr. T. K. Glennan, said:

"By any measure, however, the probe has stamped itself a true pioneer of interplanetary space."

C. E. Burnett, division vice-president, RCA industrial tube products department, said that the metal-ceramic construction and sealing techniques used for the Cermolox line of power tubes employed in the Pioneer V space-probe operation was developed over a period of 10 years by engineers of the RCA Electron Tube Division. This design permits construction of smaller, more rugged tubes that are capable of withstanding blast-off shock, vibration, and temperature extremes encountered in present space-age application.

"The Cermolox line of tubes employs a unique construction and fabrication process that permits, for the first time, perfect alignment of grids. The result is a performance level heretofore not achieved in power tubes."

This family of RCA tubes ranges in size from about that of a walnut to a grapefruit. The tube types are capable of continuous power levels from a few watts to 10 kilowatts. They range in price from $40 to over $1,000. Those used in the satellite are in the $65 price category.

The life expectancy of the tubes in the Pioneer V transmitter is such that the small radio station could transmit 1 hour a day for the next 10 years. Space experts believe that the tubes will still be full of life long after the vehicle has completed its usefulness.

Another unique feature of the metal-ceramic power tubes is their adaptability to heat sink techniques, thus permitting smaller package sizes. **EE**

THESE FOUR RCA ceramic-metal electron tube types (above) are largely responsible for the launching, tracking, and powerful new "voice" of the Pioneer V solar satellite. Shown (*left to right*) are: RCA developmental type A-2629 used in the 150-watt radio transmitter of the 94.8-pound man-made planetoid, the RCA-6816, RCA-7213, and RCA developmental type *A-2545* employed for issuing commands to the satellite from ground tracking and triggering stations in England and Hawaii. The *6816* and *7213* were also utilized in the guidance system of the Thor-Able rocket which launched the paddlewheel satellite on March 11. *Right:* C. E. Burnett, division vice-president, industrial tube products department, RCA Electron Tube Division, holds a model of the Pioneer V paddlewheel space scout and a tube sample.

BLANK for the largest fused silica mirror ever made is shown (above, *left*) before the giant piece was precision ground and polished. The blank was produced by Corning Glass Works for Project Stratoscope II. It will serve as primary reflective piece in a 36-inch telescope to be carried aloft by an unmanned balloon for outer-space photography.

The blank measured 37 inches in diameter, was 5½ inches thick, and weighed 450 pounds. *Above right:* Optical surface of the mirror is checked after precision finishing operation. The finishing was done by Perkin-Elmer Corporation.

Corning Glass Works Photos

Fused Silica Mirror for Balloon Telescope

The largest fused silica mirror ever made will serve as the primary reflective piece in a 36-inch telescope to be carried aloft by an unmanned balloon for outer-space photography.

The mirror blank, produced by Corning Glass Works, measured 37 inches in diameter, was 5½ inches thick, and weighed 450 pounds.

Project Stratoscope II

The blank—or boule—was precision ground and finished by Perkin-Elmer Corp., Norwalk, Conn., for installation in the telescope system the firm is constructing for Project Stratoscope II.

Goal of the project is to obtain photographs of planets and other celestial bodies at altitudes above the turbulence of the earth's atmosphere. It is planned to send the balloon to an altitude of over 80,000 feet.

Project Stratoscope II is being conducted by Princeton University with funds from the National Science Foundation, the Office of Naval Research, and the National Aeronautics and Space Administration.

Dr. Martin Schwarzschild, of Princeton's Department of Astronomy and director of the project, said the balloon flight is scheduled for sometime in 1961.

The project is forerunner to proposed satellite observatories and follows the successful balloon flights under Project Stratoscope I in which a 12-inch telescope provided the clearest pictures yet taken of the sun (*Electrical Engineering*, October 1959, pp. 1058-60).

With the larger telescope, it is expected that new photographs will provide information on the atmosphere of Jupiter and Venus, permit analysis of the division of Saturn's rings, and provide a means of measuring the diameter of Pluto. The project also may shed further light on the Great Nebula in Orion where new stars apparently are forming in dense interstellar clouds.

Fused silica was specified for the telescope mirror because of its near-zero thermal expansion. Sudden and severe temperature changes will not alter shape of the mirror, thus assuring distortion-free images.

The material is formed by a special technique developed by Corning.

It is said to be one of the purest man-made substances. Impurities average less than one part per million.

Fused silica is used for ultrasonic delay lines in radar systems and for lenses, prisms, and other products made for special optical uses. **EE**

Fernico-5— New Alloy Developed

A new alloy "Fernico-5" was announced recently by Dr. Guy Suits, General Electric Company vice-president and director of research. "Fernico-5 is of major significance," Dr. Suits said, "because it closely matches the thermal expansion of alumina, the ceramic that possesses probably the best combination of properties for general use in the electrical industry.

The thermal expansion of alumina, it was pointed out, is much lower than that of the metals and alloys normally used in metal-to-ceramic seals. For this reason it has not been possible for the electrical industry to take full advantage of the high strength, high heat resistance, and excellent insulating properties of alumina.

"With the advent of Fernico-5," Dr. Suits said, "we now have an inexpensive and easily fabricated alloy that will enable us to use alumina in such products as electron tubes, thermionic energy converters, capacitors, switchgear, and high temperature circuits—all of which require ceramic-to-metal seals."

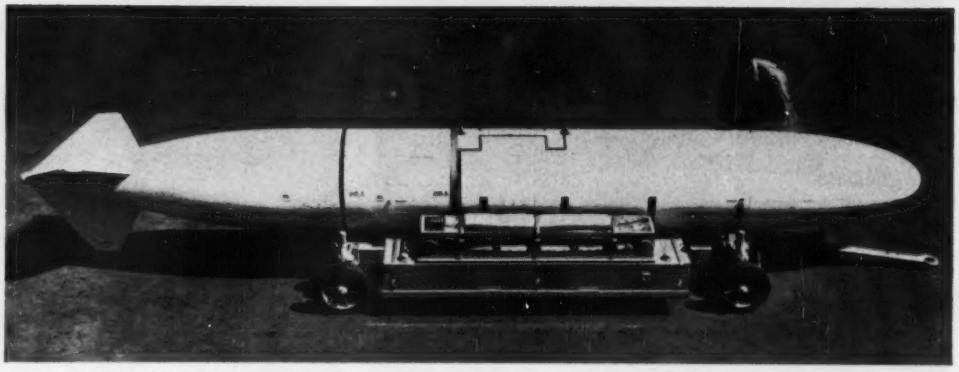
"Moreover," according to Dr. Suits, "the development of Fernico-5 will advance various applications of Lucalox alumina, the translucent ceramic announced by General Electric in September 1959."

Fernico-5 combines iron, nickel, and cobalt in a unique ratio. The new alloy was developed by G. D. Oxx, Jr., of the General Electric Research Laboratory, who pointed out that the desired, low thermal expansion of Fernico-5 is achieved by optimizing the ferromagnetic properties in this iron-base alloy. A unique feature of Fernico-5 is that it is vacuum melted. The use of this process permits melting without addition of other elements, such as manganese or silicon, to control oxygen levels. The absence of these elements means consistent control of expansion characteristics and other properties vital to sealing with alumina.

"Vacuum melting also permits better control of the iron, nickel, cobalt ratio," Mr. Oxx stated. "This is important because the expansion coefficient of Fernico-5 is unusually sensitive to variation in the amounts of these elements. Such variation can also cause a transformation from the normal face-centered cubic crystal structure to body-centered cubic near room temperature. Such a transformation has a drastic effect on expansion.

"A third advantage of vacuum melting," Mr. Oxx said, "is in the inherent low gas contents of the resulting metal. For those applications where service in vacuum or controlled atmospheres is involved this is an important consideration." **EE**

Support the New United Engineering Center



PEACEFUL torpedo built for the U.S. Navy by The Garrett Corporation's AiResearch Manufacturing Division, Phoenix, Ariz. The 26-foot-long unit serves as a complete power package to keep Navy jets ready for emergency takeoff. It can also fly along to advance fields, riding under an aircraft as do usual explosive-carrying torpedoes.

Power Pods for Navy Aircraft

A 26-foot-long torpedo-shaped power unit designed for external aircraft transport is currently being delivered to the U.S. Navy. The complete turbine-driven ground support package is built by The Garrett Corporation's AiResearch Manufacturing Division, Phoenix, Ariz.

The new power pods are designed for ground support of the Navy A3J Vigilante, and F4H Phantom II aircraft.

Driven by an AiResearch combination compressor-shaft power gas turbine engine, the multipurpose pods provide: a 60-kva 400-cycle source for ground instrument checkout; refrigeration for cooling of both aircraft electronic compartments, and for the pilot suit; and bleed air for engine starting at pressure ratios of either 3.6 or 5 to 1.

Dual air capability permits main engine starting through air turbine starters at 3.6 to 1, or J79 impingement starting at the 5-to-1 ratio.

The 5-to-1 bleed is also used by the air cycle air-conditioning system (built by the AiResearch Los Angeles Division) and for the pilot pressurization system.

The 1,638-pound power pod features aerodynamic design for external transport slung under the aircraft. A companion cradle-type trailer makes it easily handled on the ground. The unit is 26.2 feet long with a 2.9-foot maximum diameter.

The pod concept for external air transportable ground support equipment was first developed by AiResearch and Douglas for the Navy in 1950. This 456-pound 12-foot-long pod housing an AiResearch turbine compressor is still in widespread Navy use. One of the units is carried by the Navy aerobatic team, the "Blue Angels" to start their F11Fs. **EE**

High-Intensity Acoustical System

A large high-intensity acoustical system that is unique in many ways was shipped recently by the Stromberg-Carlson Division of General Dynamics Corporation to Wright-Patterson Air Force Base, Ohio.

Most unusual feature of the system is the high-fidelity quality of its performance—the generation of undistorted sound throughout the full 11-octave range of normal audibility, and from the threshold of hearing to maximum volume. The latter would be such as to damage any human ears at close range.

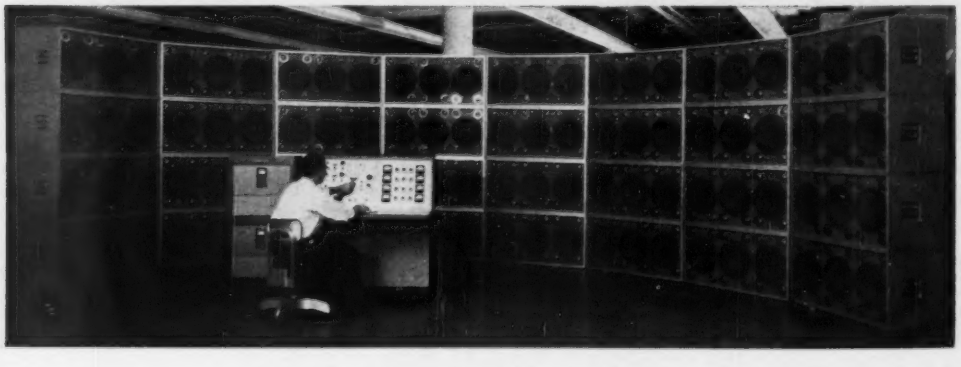
The system was developed by Stromberg-Carlson for the Aerospace Medical Division of the Wright Air Development Division, and will be used in studies of the physiological effects of high-intensity sound. The system was designed and built in Stromberg-Carlson's Commercial Products Division, by the Acoustical Engineering Section.

The "business end" of the system is a huge assembly of loudspeakers—480 in all—mounted in 32 separate baffles for maximum flexibility in arrangement and control. Each baffle contains 3 low-frequency "woofers" and 12 high-frequency "tweeters." All the transducers are especially designed and built to deliver "high fidelity" sound quality at unusual acoustical power for sustained periods of operation.

The system is controlled from a console providing four possible inputs—sine wave, electronic "white noise," tape recording (of jet engine, missile, or other noise), or an external source.

An adjustment is provided on the preamplifiers to establish a specified line level, which is indicated by a meter. The fixed line level then is fed into a mixer, where any or all four input sources can be mixed in any desired combination. The output of the mixer goes to a line amplifier which also is adjustable to provide any specified output level. Through a master attenuator, this output goes into the main audio power equipment, which consists of two pairs of audio amplifiers. One pair of these amplifiers is for low power use only, with each amplifier providing an output of 200 watts. Each of the pair of high-power amplifiers has an output of 7,000 watts. Thus, the sound intensity provided by this system ranges from the threshold of audible sound to the extreme high levels of sound pressure. Frequency response of the system is flat over the entire audible range, from 20 to 20,000 cycles.

To avoid unintentional exposure of subjects to high-intensity sound, a unique safety precaution has been incorporated in the control console. This makes it necessary for the operator to put the controls first into low-power position before energy can be supplied to the high-power amplifiers. **EE**



ACOUSTICAL engineer at Stromberg-Carlson Division of General Dynamics Corporation makes preliminary test—at low power—of big array of loudspeakers destined for Wright Air Development Division, Ohio. There they will be a key part of a large high-intensity sound system being used in studies of the physiological effects of high-intensity sound.

Tests Begin of New Atomic Generator

Testing of a compact, lightweight generator which can convert heat from a by-product of nuclear reactors into electricity to power advanced satellites and space probes for at least a year, has been started by The Martin Company. The conversion system in the 125-watt unit uses no moving parts.

The generator, which is being developed by Martin's Nuclear Division under contract to the U. S. Atomic Energy Commission (AEC), is called SNAP 1-A (System for Nuclear Auxiliary Power). It is similar in principle to SNAP-3, a grapefruit-size device which was first demonstrated publicly by President Eisenhower early last year.

SNAP 1-A is roughly egg-shaped, 34 inches long, and 24 inches in diameter. Most of its dull metal surface is dotted with screw-headed caps marking the location of 277 thermocouples. The complete generator weighs 175 pounds.

The new system promises more power than any energy unit launched into space so far either by the United States or the Soviet Union. Some systems have combined solar cells with chemical batteries to build up to such wattage levels periodically, but these cannot operate continuously at high power.

It was pointed out the SNAP 1-A, unlike solar cells, would not be affected by the impact of micrometeorites in space. Operating independent of the sun, the nuclear unit would have the additional advantage of being able to produce power while in the shadow of the earth. The absence of moving parts in the conversion system greatly reduces the chances of any malfunction.

The fuel capsule for SNAP 1-A, which will not be inserted until electrical and environmental tests of the rest of the system are complete, will be located at the very center of the generator, supported by light metal tubing. The capsule will contain tightly sealed pellets of a radioactive material called Cerium-144, which decays spontaneously, producing heat in the metal around it.

As the inner ends of the thermoelectric elements are heated, the outside ends always remain somewhat cooler, so that the difference in temperature produces a small electric current in each pair. These thermocouples are connected in series to add up to 125 watts at 28 volts. Tests being conducted now use an electric heater to simulate the fuel.

Cerium-144 is a normal by-product of the fission process in all nuclear reactors. The material which ultimately will power SNAP 1-A is being separated from other fission products at the Oak Ridge National Laboratory of the AEC and will be supplied to Martin in sealed form early next year for use in the ground test unit.

As the radioisotope decays, the amount of heat it produces will gradually decrease. For this reason, SNAP 1-A has been built with a temperature-sensitive shutter, which will let some of the heat leak out at the beginning of operation but will gradually clamp shut. Thus, the electrical output will remain constant at 125 watts for a full year and then will taper off.

A solar cell system with the same constant output might be comparable to SNAP 1-A in weight, but would be much bulkier unless a complex mechanical device were used to keep the cells pointed toward the sun. Unoriented cells would have to cover an area of more than 100 square feet.

Extensive and conclusive tests have been carried out under contract to the AEC to assure that the radioisotope fuel of SNAP 1-A would not be released if a satellite-carrying rocket exploded on the launch pad or failed to reach orbital velocity. Once in orbit, the fuel capsule is designed to burn up completely upon re-entry into the atmosphere.

During ground-handling operations before launch, the hollow interior of SNAP 1-A can be filled with liquid mercury, which acts as a shield for its radiation. This could be drained, moments before lift-off, to reduce the weight of the payload. **EE**

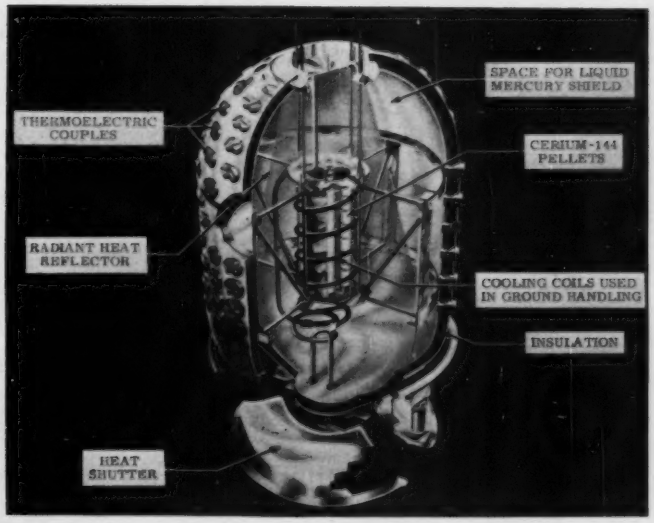
Compresto Construction and Hypalon Insulation for Cables

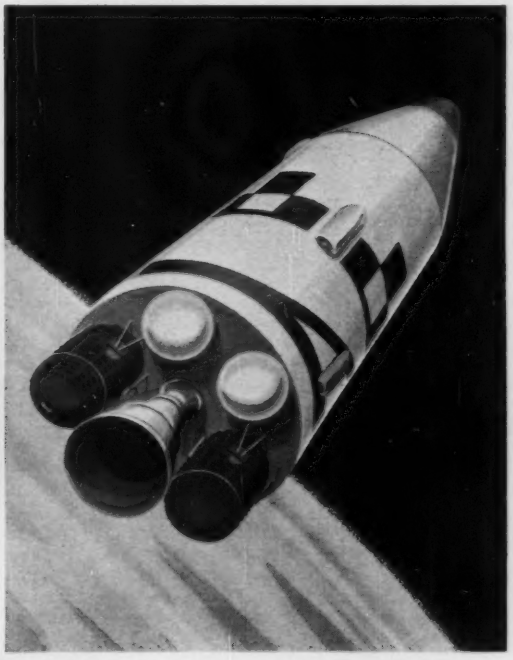
Color coding for phase identification in secondary networks is now practical as a result of the development of distribution cable combining a unique aluminum conductor wth insulation of a special synthetic rubber, it was announced by Olin Mathieson Chemical Corporation.

The cable is a product of Southern Electrical Company, the conductor manufacturing unit of Olin Mathieson's Metals Division. The synthetc rubber, called "Hypalon," is made by E. I. du Pont de Nemours & Co., Inc.

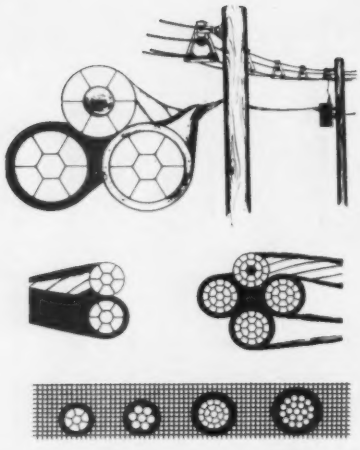
Two new improved types of conductors, featuring "Compresto" construction and covered with Hypalon, are now in commercial production by Southern Electrical. The first is cable for duplex, triplex, or quadruplex installations that combines exceptional resistance to weather, ozone, heat, compression cutting, and cold flow with lasting coloration for color coding and positive phase identification.

The second type makes the advantages of insulation of Hypalon available in service drop wire for use where requirements include both outstanding insulation quali-





CUTAWAY drawing (above) of SNAP 1-A shows inner components of the 125-watt System for Nuclear Auxiliary Power undergoing preliminary tests at The Martin Company's Nuclear Division in Baltimore, Md. *Right:* An artist's concept shows how two SNAP 1-A units might be used on a Discoverer-type satellite to provide 250 watts of continuous electric energy for measuring instruments, recording devices, and transmitters.



COLOR-CODED CABLE: Insulation of "Hypalon" synthetic rubber gives exceptional wear and weather resistance, permits color coding and positive phase identification in secondary networks; shown (*upper drawing*) in conjunction with spaced aerial cable installation. Available in three colors, cable is also used in duplex (*left center*) and quadruplex (*right center*) constructions. "Compresto" conductors have smaller diameter, reduced weight, because of elimination of interstices between strands (*bottom drawing*).

ties and resistance to melting, burning, or flowing caused by high temperature.

Both types are the result of a long-term program by Southern Electrical to develop conductors combining the maximum in weather resistance and mechanical properties with top electrical properties in the range required for secondary networks. The program was undertaken to meet new requirements noted in power distribution as the result of heavier loads, congested networks, and other problems resulting from growing population, increased industrialization, and greater power consumption.

The specific covering used is the product of co-operative development by Olin Mathieson and du Pont.

Electrical Insulation

Hypalon was selected after extensive research because it offers an outstanding balance of properties for electrical insulation which is not found in other insulating materials, according to Southern Electrical. A true synthetic rubber, it can be vulcanized and will not flow or melt at elevated temperatures. Because of outstanding natural resistance to weathering, oxygen, and ozone, it does not require large quantities of carbon black used with other elastomers to give weather resistance. This permits the insulation to be colored in conformity with accepted industry color coding. Cable is available in black, electrical red, and electrical grey.

In addition, the electrical properties of synthetic rubber permit rating of the new cable as a 600-volt triplex. Other properties include: excellent resistance to abrasion, oils, and chemicals that may be encountered in the field; flame resistance; a high order of resistance to compression cutting; and the ability to be stripped readily from the conductor during installation.

Changing power requirements have increased the use of triplex installations. Triplex cables—two phase wires wrapped around a bare neutral conductor that also serves as the messenger—were introduced for secondaries in the early 1950's by such companies as the Portland General Electric Company and the Long Island Lighting Company. Installation costs are reduced because only one cable has to be strung and adjusted, eliminating a large proportion of the fittings required and cutting labor time.

Electrical Efficiency

Electrical efficiency is enhanced by use of triplex, Southern Electrical stated. In a No. 4/0 Awg triplex secondary, for instance, voltage drop is 26% less than in the same capacity conductor in an open-wire system. Service reliability is greater because of the cable's increased resistance to breakage from falling tree limbs and storm damage. Tree trimming is reduced, safety is improved by ability to make house or service drop connections by attachment to the messenger and phase wires at a distance of 1 to 3 feet from the pole, and pole change is greatly simplified. Another factor of increasing importance in heavily populated areas is the better appearance of a single conductor.

Triplex cables were initially used in smaller sizes for service drop installations. With the advent of the triplex in secondary networks, larger sizes were required to transmit the increased quantities of power needed to service such items as heat pumps and central air conditioning. Sizes as large as 336,400 circular mils are now in common use.

Major Breakthrough

New types of cable were needed to meet these new requirements. One major breakthrough was the development by Southern Electrical of Compresto conductors of aluminum, in which 7- or 19-strand conductors are processed to eliminate interstices between the individual wires and give a smooth outer surface which increases resistance of the finished cable to compression cutting.

Compresto construction reduces cable diameters, with corresponding reduction in ice and wind loading. Weight is also reduced by elimination of insulating compound normally wasted in filling strand interstices. In a typical No. 4/0 triplex construction, for instance, diameter is reduced 7% and weight, 4%. Surface area for bolted-type connectors and fittings is also increased.

The second major step—a colored, vulcanized, weather- and wear-resistant insulation of good electrical properties—resulted from the development by du Pont of a new type of Hypalon synthetic rubber, which is characterized by a special combination of physical, chemical, and electrical properties, and is economical and easy to process. This new type of chlorosulfonated polyethylene underwent extensive study at Southern Electrical. When a practical compound was developed with the requisite balance of properties, it was adopted for the new cables.

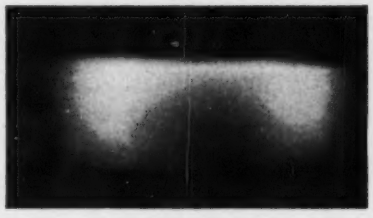
Service drops and secondaries using cable insulated with Hypalon synthetic rubber have been installed on the systems of several large utilities. **EF**

Electromagnetic Plasma Accelerator

Successful demonstration of a new phenomenon in the physics of hot gases which will pave the way for development of advanced space propulsion systems has been announced jointly by the U.S. Air Force Office of Scientific Research and Litton Industries.

The announcement came after a series of experiments on gas plasmas, conducted as part of a research program underway since 1957 in Litton's Space Research Laboratories, Beverly Hills, Calif.

The experiments were performed with the aid of a device which, at present, is mainly intended to advance knowledge in the control of hot, ionized gases and to



Plasma Gas Toroid

provide basic information upon which the design of future propulsion systems can be based. This device is called an "electromagnetic plasma accelerator."

Electromagnetic fields in the device act on a gas in such a manner as to convert it into a conductor of electricity and to form it into a donut-shaped "plasmoid" which is trapped and accelerated at extremely high velocities within the fields. Acceleration takes place in a direction perpendicular to the plane of the plasmoids and is accomplished without loss of the plasmoid shape.

Litton scientists explain that this is equivalent to making a smoke ring and propelling it at speeds in excess of 250,000 miles an hour without distorting the shape of the ring. The gas "donuts" have been photographed while emerging from the experimental device.

The techniques employed in the formation and acceleration of the plasmoids are original with Litton scientists who indicate that the new method eliminates the problems of electrode erosion, wall friction, and low efficiency which have been serious obstacles to the successful development of plasma space propulsion systems. Also, Litton's approach is not limited by the containment problems which have confronted other researchers in the field of plasma physics.

The experiments are continuing and Litton scientists said it soon should be

possible to accelerate gases to a sizable fraction of the velocity of light.

Photographs of Gas Toroids

The following is a brief description of the manner in which the photographs of the plasma gas torid or plasmoid was obtained. The gas toroid leaves the accelerator and passes down a 6-inch-diameter evacuated pyrex glass tube. A rod of lucite is placed across the tube at some point about 1 foot from the last accelerator coil, and when the toroid strikes, light is produced on the rod. The toroid does not itself make much light due to the fact that it is too hot, but the portions of it which strike the lucite are cooled off, and light, thereby, is produced.

The photograph was obtained with an ordinary press-type camera with a long shutter time. Therefore, it presents an integrated picture of all effects which occurred when plasma struck the lucite. The two regions of high light intensity which result when the toroid hits the lucite rod do not accurately show the cross-sectional shape of the toroid. Rather they show the net result of the original shape of the plasma plus gas bouncing and scattering which subsequently occurred. The two regions of high light intensity are, therefore, much thicker than the original dimensions of the plasma toroid. It should be noted that there is little or no light appearing below the lucite bar. This is consistent with the statement that impacting gas toroids are too hot to make light. Since the lucite rod was thin and only cross-sectioned the toroid, the majority of the gas composing the toroid passed on by the rod. This gas does not make light as can be seen from the photograph. **EE**

Wind Tunnel Tests Components at High-Speed in Bad Weather

Components for missiles and high-speed aircraft are being performance-tested at speeds up to Mach 2.7 and under icing conditions in a versatile new jet-engine-powered wind tunnel at Cook Electric Company, Morton Grove, Ill.

Supersonic, transonic, and subsonic test sections are available for important airflow projects scheduled by the company and its clients including research organizations, and aircraft, aircraft component, ordnance, and guided missile manufacturers. This facility occasionally is also used to determine the wind resistance of new "civilian" products such as street lamps and roofing materials.

An icing simulation facility provides environments equivalent to natural atmospheric conditions of temperature, moisture content, and droplet size with air velocities over the test item covering the entire subsonic range or higher if desired.

The tunnel also has an open-end test section which permits analysis upstream of the test model. Planned for incorporation into the unit is an additional circuit which will provide a hypersonic airflow capability.

The continuous-flow open-circuit atmospheric induction-type tunnel is probably the largest multipurpose wind tunnel in the country, Cook officials agree. It is powered by two General Electric J-47 turbojet engines which generate about 5,000 pounds of thrust each.

Force, pressure, and temperature readings can be obtained, along with rapid-frame camera recording to give an analysis of models under test. Icing tests on small instruments or models can be run in the icing tunnel which provides temperatures comparable to those found in natural cloud formations, around −20 F.

Air is cooled to this temperature by a series of six radiators containing trichloroethylene.

Cardox Division of Chemetron Corporation provides bulk carbon dioxide used to cool the trichloroethylene in a storage tank by direct injection. The coolant is then pumped in a closed system through the radiators and back into storage where it is again brought to its low temperature setting. The CO_2, which becomes a vapor upon release into the tank, is exhausted from the top of the chamber.

The tunnel's supersonic test section is capable of attaining a Mach number range of 1.3 to approximately 2.7, according to Cook engineers. This section is preceded by an asymmetric sliding-block-type nozzle to be adjusted for free stream Mach numbers between these limits, and the change in speeds can take place while the tunnel is operating.

Flow visualization is accomplished by a rail-mounted optical system. Two window ports in the side walls of the 22- by 24-inch test chamber are used to photograph shock wave patterns at different places.

The transonic test section is preceded by a fixed wall nozzle to obtain a free stream Mach number between 0.85 and 1.35. At the test section, walls have a porous construction with a surrounding plenum chamber to cancel and attenuate shock waves generated by the model.

Flow visualization in this chamber (the same size as the supersonic section) also is accomplished with the adjustable optical system. Three window ports in the side walls are used to photograph testing.

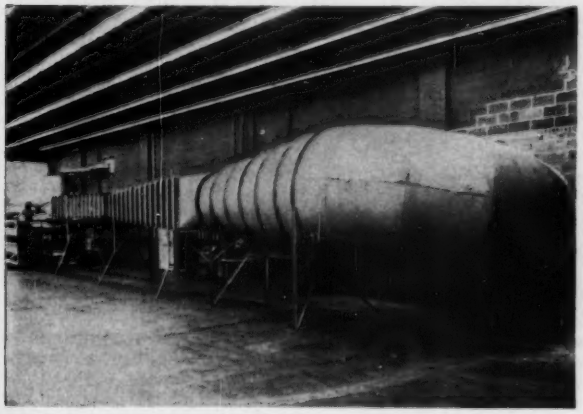
Two subsonic test sections are 2 by ½ feet and 2 by 2 feet in size. Visualization is accomplished easily through large windows on each side of the sections. It is feasible to inject smoke into the airstream to permit visual studies of flow conditions around the test specimen.

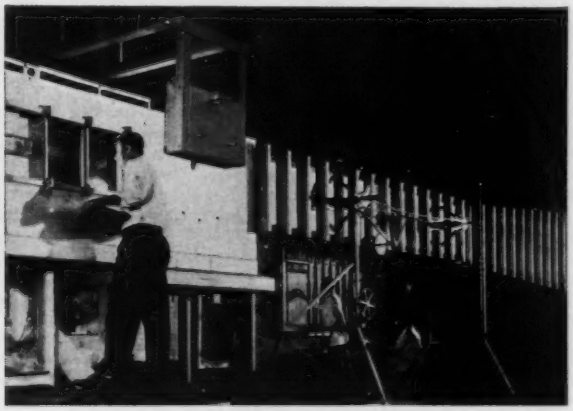
Air routed through these sections is passed through a desiccant bed containing 75,000 pounds of activated alumina, and dried to a dew point low enough to avoid condensation effects at the test section.

During icing operations, a bank of six nozzles injects a water-air mixture into the airflow before it reaches the model. Mixture is determined by a flow meter.

The open-end section uses air direct from the atmosphere for low-speed testing in two sections, 2½ by 2½ feet and 4 by 4 feet in size. Large windows are provided for observation of the test model, and force, pressure, and temperature readings can be obtained, along with rapid-frame camera recording.

It is possible to use the wind tunnel for bleed air tests. The two engines have provisions for extraction of compressor discharge air to test various instruments, anti-icing equipment, air conditioning,





BIG BEND *(above, left)* **routes blast of air into room housing twin jet engines which power Cook Electric Company's wind tunnel in Morton Grove, Ill.** *Above, right:* **Engineer watches test through thick glass observation window. Tunnel has supersonic, transonic, and subsonic test sections for airflow projects of the company and its clients including research organizations and aircraft manufacturers.**

and defrost systems. Seven air extraction ports are located on the compressor frame of each engine.

The tunnel is easily adapted to different airflow regimes. In the subsonic flow range, complete models or components of aircraft can be tested. Tests of drag chutes and recovery chute characteristics can be performed in the open-end tunnels with complete operations sequence recording by use of rapid-frame cameras. Drag forces and wake studies during chute deployment can be studied.

Measurment of all six forces important to analysis of aerodynamic bodies, lift, drag, side force, rolling, yawing, and pitching, can be recorded. It is also feasible to perform pressure distribution, boundary layer survey, wake survey, and momentum loss tests.

Complete study of droplet size, ice formation, and airflow characteristics can be made during icing tests, and the wind tunnel configuration is adaptable for modification to perform rain erosion tests.

For the transonic and supersonic flow regions, pressure surveys can be made, and through the utilization of strain gauge balances, longitudinal forces and moments can obtained. Computer facilities are available to perform data reduction and plotting. **EE**

New System Sends Messages At Ten Times Normal Speed

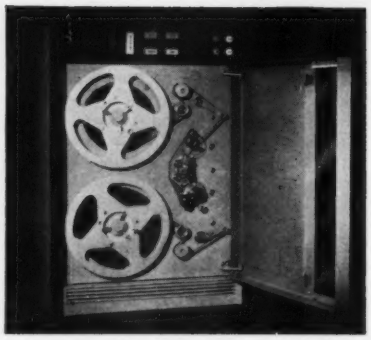
"Comex," a new concept in communications that can transmit a 3,000-word message over a telephone line in 3 minutes, was announced recently by the Crosley Division, Avco Corporation. The same message would take from 30 to 50 minutes to transmit via ordinary teletypewriter.

Available under a leasing arrangement, for $130 per month, Comex has already been installed by the Westinghouse Electric Corporation and the Department of Defense.

F. C. Reith, president of the Crosley Division, and vice-president of the Avco Corporation, said significant cost savings in line charges can be obtained by users of Comex. "These savings stem from the ability of Comex to utilize standard telephone lines to transmit messages in one-tenth the time required on a teletypewriter circuit using standard teletypewriter procedures and equipment," he stated. "Although telephone circuits normally cost somewhat more than teletypewriter circuits, this cost disadvantage is offset by the greatly reduced transmission time of Comex."

Each Comex unit consists of a 2-speed magnetic tape recorder capable of recording the output of a standard teletypewriter on magnetic tape at slow speed. The magnetic tape is then run at ten times the slow speed as it is transmitted over a standard telephone circuit. This high-speed message is then recorded by a second Comex unit. This recording is then fed into a teletypewriter at slow speed and the message printed out.

Mr. Reith went on to say that "Comex will provide a practical solution to the growing requirements for long-distance data transmission, and is the answer to rising communication costs that face multiplant organizations. Its applications range from administrative correspondence to shipping data, and from accounting information to reservations."



COMEX *104* high-speed data transmission system. Developed by Avco Corporation's Crosley Division, Comex transmits data in one tenth time required on teletypewriter circuit. Comex accepts messages from presently installed printers or paper tape transmitters at speeds of 60 to 100 words per minute. It transmits this information without distortion over a standard telephone circuit at speeds of 600 to 1,000 words per minute. The system is capable of storing up to 12 hours of message information. Comex units weigh 150 pounds and are completely transistorized. During operation, a minimum of noise is produced and there is no vibration. Delay time between the end of recording and the start of reproducing signals is less than 5 seconds. Sensing devices are employed to stop the machine automatically when minimum recording capacity is approached.

Comex has been developed to be compatible with American Telephone and Telegraph Company's expanding service for transmission of teletypewriter messages and data over regular long-distance telephone lines. It can be used with all presently installed teletypewriters and is specially designed for connection through the Bell Data-Phone unit to insure adaptability to any installation calling for wire service.

"In many instances Comex eliminates the need for privately leased telephone lines by using ordinary telephone lines," Mr. Reith stated. "Often the need for a subscription to a message teletypewriter service can be eliminated by installing Comex units," he added.

The units are small, compact, and weigh 150 pounds. During operation, a minimum of noise is produced and there is no vibration. Delay time between the end of recording and the start of reproducing signals is less than 5 seconds. Sensing devices are employed to stop the machine automatically when maximum recording capacity is approached.

Completely transistorized, Comex accepts messages from presently installed printers or paper tape transmitters at speeds of 60 to 100 words per minute. It transmits this information without distortion at speeds of 600 to 1,000 words per minute. The system is capable of storing up to 12 hours of message information. Firms which have installed Comex find it advantageous to store the information during the working day and then transmit it after hours so as to take advantage of lower telephone rates.

All manner of business correspondence can be transmitted by Comex. When messages have been accumulated for a city, a long-distance telephone call is made to the Comex installation at the particular destination. The answering operator is told to put her Comex unit into receiving condition and the information is transmitted ten times faster than the original record.

Comex can be adapted for use by airlines, trucking companies, military and Government agencies, food manufacturers, publishers, suppliers, and any organization that is faced with the necessity of tightening its communications network with outlying plants or offices. **EE**

Giant Electronic "Eye" To Spot, Track Spacecraft

A radar Cyclops known as ESAR, capable of focusing its electronic "eye" simultaneously on space vehicles and aircraft at lower altitudes, is being developed by The Bendix Corporation, it was announced recently.

A new $4 million contract authorizing construction at the company's Radio Division (in Towson, Md.) of a 5-story demonstration model of the computer-controlled ESAR (Electronically Steerable Array Radar) has been signed with the Air Force Rome (N.Y.) Air Development Center and the Advanced Research Projects Agency, according to the announcement by A. E. Abel, general manager of the division.

ESAR not only can "look" at a wide expanse of space without turning its "head" or antenna, but can track and communicate with the numerous craft that will be spotted by its "eye" at a glance, Mr. Abel said.

"The electronically steerable feature permits ESAR to look at a great number of objects over a wide area at one time," he said. "Yet it has the ability to concentrate on one particular object while keeping the other objects in view. This ability is made possible through the development of a system using multiple electronic search and track beams without the need of moving parts such as are used for the mechanical rotation of a conventional antenna."

The ESAR model will be a windowless structure with one entire wall slanted and made of plastic to enable the "eye" to peep through it. It will be used to track space vehicles launched from Wallops Island, Va., and to monitor airway traffic in the Baltimore-Washington flight area.

The program that led to the development of the radar system resulted from research begun by the Bendix division several years ago in the field of ESAR techniques under the joint director of the Rome Air Development Center and the Advanced Research Projects Agency.

The first phase of the program was the

development and testing of a small section of ESAR housed in a 125-foot structure on the roof of the division's engineering laboratory. EE

New Building Features Aluminum Electrical Products

Kaiser Center, rising impressively over Lake Merritt in downtown Oakland, Calif., is a showcase of aluminum electrical products.

In all, the new 28-story structure—largest office building west of Chicago—uses more than 2 million pounds of aluminum electrical and architectural materials. This adds up to over 2 pounds for each of the 976,000 square feet in the office building.

The electric system employs 370 miles of aluminum wire and cable, plus 30 tons of aluminum conduit and bus bar. A majority of the 24,000 lighting fixtures are equipped with aluminum egg crate diffusers, and aluminum is used extensively in other special lighting fixtures.

An example is the exclusive use of No. 10 aluminum wire for lighting circuits. This wire is used from lighting panels to the copper leads of lighting fixtures.

Many other sizes of aluminum wire and cable are employed, ranging up to 500 MCM (thousand circular mils). The 2 million feet of aluminum conductor represents one of the largest installations of its kind in a commercial building. All wire and cable—except cellular floor and minor control cable—are aluminum.

Both aluminum-to-aluminum and copper-to-aluminum cable splices were made in the same manner with compression connectors. Some 100,000 wire splices—mainly on lighting fixtures—were made with connectors having a locking mechanism housed in a plastic cup. An oxide inhibitor was poured into the cup to seal the joint and to prevent an oxide coating from forming on the conductor.

The aluminum rigid conduit used in Kaiser Center ranges in size from ¾ to 3½ inches. Several thousand feet of bare aluminum conduit have been buried directly in concrete.

The 32,000 pounds of bus duct is of the low-voltage drop type. Regular LVD duct runs from transformers to switchgear and LVD plug-in busway runs from switchgear to other distribution points.

Installation of 16,000 fluorescent lighting fixtures was done in a manner which virtually extended the manufacturer's factory production line. Plywood pigeonholed cases, each containing 21 recessed fixtures with 277-volt ballasts were loaded at the factory, along with removable 4-wheel dollies to fit the bottom of each case.

At the building site, both dollies and cases were hoisted by crane to the proper floor. Then the dolly was affixed and the case rolled to the prescribed area. Three men—one handling and the other two installing—connected the fixtures to the already wired lengths of flexible conduit, moving quickly from one end of each floor to the other.

Primary service into the Center is 12 kv, supplied by Pacific Gas & Electric Company through five feeder cables. Power then goes into a bank of ten 1,000-kva transformers reducing it to 480/277 volts.

From transformers, the power is sent to three 4,000-ampere switchgear points in the basement, then along feeder busways to panels and other distribution centers.

On each floor there are three electric rooms where plug-in switches can be installed in the bus duct system. In general, each electric room has a plug-in switch to feed a 120/208-volt transformer and panel to supply floor receptacles and incandescent lamps, and another switch to feed a 277-volt lighting panel.

Current limiting fuses are used with the plug-in switches throughout the bus duct system and moulded case breakers are used for branch circuit protection. EE

The Levacar— Vehicle of the Future

Engineers looked to the future recently and saw a revolutionary land vehicle, called a "levacar," that may some day travel from city to city at 500 miles per hour or more, sliding on a thin film of compressed air. Leaving from downtown terminals, and eliminating travel to and from remote airports, such vehicles could cut hours from intercity travel time.

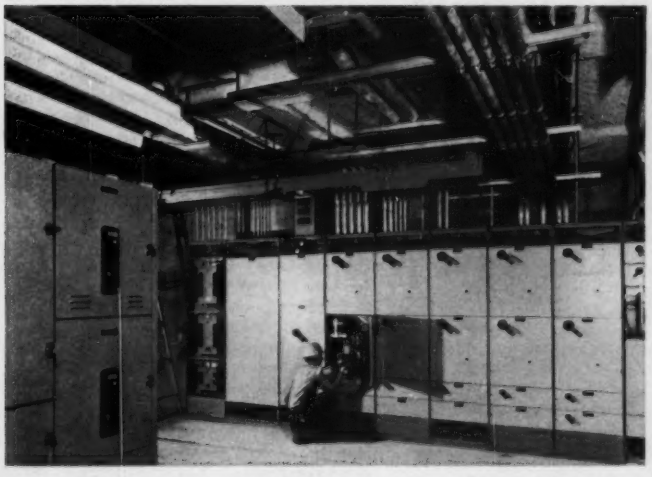
A. L. Haynes, of the Ford Motor Company, said his company has already built experimental levacars and is continuing to develop the idea.

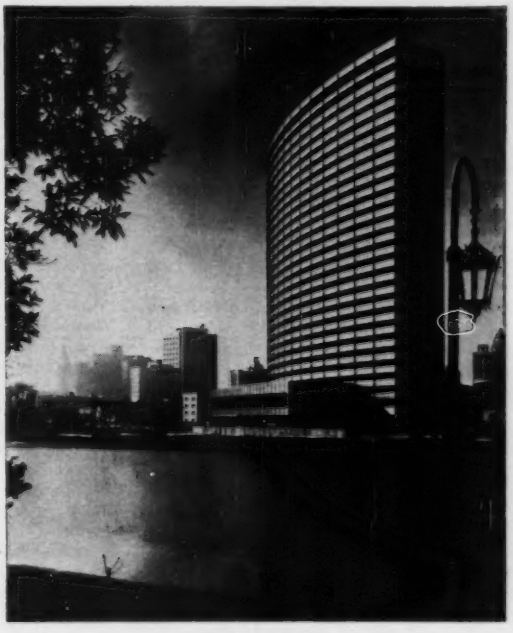
In operation, levacars carrying a number of passengers are mounted on flat-topped tracks, similar to railroad tracks. A stream of compressed air fed to "levapads," which fit around the track, lift the vehicle a fraction of an inch above the track surface, virtually eliminating friction, while an aircraft engine provides forward push.

Mr. Haynes remarks were contained in a paper prepared for delivery at the Semi-Annual Meeting and Aviation Conference of The American Society of Mechanical Engineers. Co-author of the paper was D. J. Jay, also of Ford.

The paper pointed out that today's high-speed jet airplanes traveling a few hundred miles between cities barely leave the ground before they have to start landing at their destination. Passengers

Kaiser Aluminum Photos





KAISER CENTER *in downtown Oakland, Calif. (left)* **is a showcase of aluminum architectural and electrical products. More than 2 million pounds of aluminum are used throughout the 28-story structure. This includes 1,230,000 pounds of grey and gold aluminum alloy used to compose a sweeping facade, over 2 million feet of aluminum wire and cable, plus 30 tons of aluminum conduit and bus bar.** *Above:* **Motor control center distributes power to 80 motors operating in the Kaiser companies' new international headquarters.**

traveling a few hundred miles may spend much more time traveling to and from the airport than in the air, and conventional railroads and automobiles are limited to speeds no greater than 100 miles per hour. Any wheeled vehicle, it was stated, is unsatisfactory for speeds above 150 miles per hour because of excessive vibration and wear.

Levacars, the authors said, could travel at speeds of 200 to 500 miles per hour over metal rails that would be cheaper and easier to install than conventional roads and would provide added safety as well. This system of sliding on air, together with automatic controls, they said, "is the foundation of safe, economical, high-speed transportation substantially independent of weather conditions."

They added, in their paper: "With respect to existing modes of intercity transportation, this new mode offers numerous advantages. Since the levacar rides on the ground, it will be safer than air travel, because most failures on the ground will permit the vehicle to slide to a stop. The air supply will usually function for a short period of time after power failure, permitting the vehicle to slide to a stop with little if any damage. Even if air flow were not to continue at all, the vehicle would merely slide to a stop on the levapad; from full speed it would reach positive arrest in less than two miles. On the other hand, the metal surface of the levapad would last for seven miles of sliding before total failure would occur, thus assuring passengers of complete safety for at least one emergency stop. The metal surfaces could then be replaced at relatively little cost. An additional safety feature exists because a number of levapads are arranged to clamp around the rail, leaving no danger that the vehicle may leave the rail.

"Fundamentally, a levacar is an airplane except that in flying very close to the ground it needs neither wings nor tail surfaces.

"Any lightweight engine is satisfactory as a source of power, and the same engine can also be used to provide the compressed air for the levapads."

The authors concluded that, "It is, of course, too early to tell exactly what the future has in store for the levacar. To date, we have established the feasibility of the system and are continuing to develop the technology. We know that, given a reasonable amount of time, personnel, and money, a working system could be installed. Beyond this point, demand will guide its application and ultimately create its place in transportation. It will probably replace nothing, but instead will add a mode of its own that will help make travel more comfortable, safer, and still more economical than it is today." EE

Underwater Television Installation

The deep-water television observation system, which has been developed to operate the U.S. Navy's remote-control ocean bottom crawler, was fabricated by Orbitran Company, Inc., Lakeside, Calif., under contract to the Marine Physical Laboratory (MPL) of the Scripps Institution of Oceanography, an activity of the University of California. The vehicle was developed under the sponsorship of the Office of Naval Research, with Scripps as the prime contractor.

Under development for more than a year in co-operation with the scientists of Scripps' MPL, the unique television system utilizes four underwater cameras. These are designed to monitor from the beach the operation of the vehicle and its manipulating arm and hand which can perform a variety of tasks for extended periods of time at an unprecedented 5 miles below the surface. Illumination for the cameras at pitch-black ocean depths is provided by mercury vapor lights attached to the ocean rig. The Navy calls this vehicle RUM (Remote Underwater Manipulator).

According to Orbitran's president, R. J. Price, the apparatus can transmit two- and three-dimensional views of the ocean bottom and the surrounding area with the picture fidelity of home television reception.

"While this system will be used for government-sponsored research," Mr. Price said, "we believe similar units offer enormous potentialities to commercial industry. They could prove invaluable, for example, in deep-water salvage operations, underwater survey work, offshore construction and inspection, and rock formation studies."

The following description of the deep-water television installation was given:

Four cylindrical television cameras, each housed in ½-inch steel casing capable of withstanding 10,000-psi pressure, constitute the "eyes" of the observation unit. Each miniaturized camera is 3 inches in diameter and 14 inches long, and is connected by double-jacketed oil-insulated cable to a central control unit which also operates at extreme depths.

The control unit, also tube-shaped and mounted in ½-inch steel casing, performs several functions. It contains the power supply for each of the four cameras, plus video switching and power amplifiers for transmitting signals to the surface. The central unit also transmits sweeps or scanning signals to each camera.

Through the central control unit, any one of four camera images can be selected for transmission to surface monitors, or the images of any two cameras for simultaneous three-dimensional transmission.

A single coaxial cable provides the sole link between the submerged television components and receiving and monitoring equipment above water. In addition to transmitting 60-cycle primary power for the operation of the cameras and mercury vapor lights, the steel-braided cable carries television signals along with numerous remote-control and telemetering channels.

The television system operates over a 500-kc bandwidth in the following fashion:

When the image of one camera is called for on the surface monitor, the picture is transmitted at the rate of 15 scans or frames per second—about equivalent to the clarity of a good home movie camera. If a three-dimensional view is desired, the images of two cameras are intermittently transmitted at 7½ scans per second.

The television system can transmit either high- or low-resolution images. Low-resolution transmission produces a horizontal scan of 3,750 cps and a vertical scan of 15 cps, resulting in a 250-line picture. In high-resolution transmission, the horizontal sweep rate is changed to 2,000 cps, and the vertical scan changes to 3¾ cps to produce a 530-line picture. The phosphorized "long-persistence" monitor screens are fitted with orange filters to prevent an image from fading during the split-second interruptions in signal transmission.

Among other features of the underwater television system are the shielding devices which safeguard the cameras against enormous sea water pressure. A 2-inch conical lucite window is sealed to the front of the steel housing to protect the vidicon tube, the only vacuum tube in the otherwise completely transistorized cameras. At the rear of each camera is a precision-machined steel terminal header through which the connecting cable passes. A rubber boot, attached to the header, contains insulating oil to protect the terminal connections against sea water.

Each camera occupies about 100 cubic inches and contains video preamplifier, horizontal and vertical sweep, remote control, iris, focus, and sweep loss protective circuits. EE

Beams of Electrons Weld Space Metals

A new welding process using a high-powered electron beam gun may speed up the fabrication of space ships and other outer-space vehicles, according to a recent report.

Manufacturing research engineers at Republic Aviation Corporation say they have made progress in achieving welded joints capable of withstanding temperatures up to 3,000 F through use of the new technique. The procedure, developed in the company's manufacturing research department, Farmingdale, N.Y., has been applied to such space-age metals as molybdenum alloy and pure tungsten. Molybdenum and tungsten are two metals considered ideal for use in outer-space craft because of their resistance to extremely high temperatures.

The electron beam gun operates in a cylindrical vacuum chamber which establishes a contamination-free atmosphere for welding. The weld joint area is bombarded with a narrow, concentrated beam of fast-moving electrons to generate the heat of about 6,000 F required for the welding. Welding speeds reach as high as 1 inch per second, which is approximately 150% faster than other welding processes, the engineers explain. It results in welded joints that have deep penetration and narrow weld beads, and are virtually free of contamination which often makes a joint susceptible to fracturing due to brittleness. EE

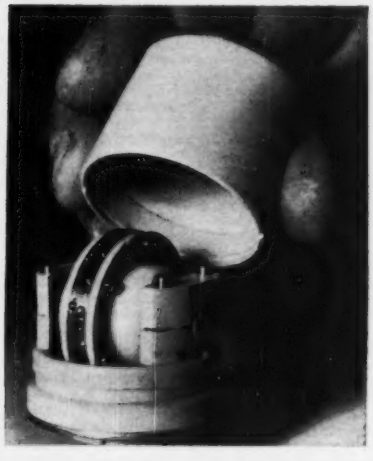
Ceramic Gyro Developed for Space Guidance

The aerospace industry's first ceramic gyroscope, said to represent a tenfold improvement in gyro accuracy, has been developed by the Aeronautical Division of Minneapolis-Honeywell Regulator Company.

Designed for space use, it incorporates gas lubricated spin motor bearings.

It was disclosed that the gyro was made possible by two major achievements. One was Honeywell's development of a ceramic material as hard as sapphire that can be diamond-honed into the tiny and ultra-precise shapes of critical gyro parts. The other was the development of a miniature ceramic self-generating gas bearing.

The combination of ceramics and gas bearings has sharply reduced the prime causes of gyro drift inaccuracies, it was stated and has resulted in a gyro with a theoretical life span approaching infinity.



TINY new gas bearing gyro is dwarfed by a human hand. Shown here is the ceramic spin motor of Minneapolis-Honeywell's new super-accurate space guidance gyroscope about to be encased in its ceramic gimbal. The use of precision ceramics made possible the first miniature application of gas bearings in gyroscopes.

Previously, gyroscopes have used ball bearings which, it was pointed out, are relatively unstable and subject to wear.

The ceramic bearings in the new gyro are lubricated by a film of gas only 25 millionths of an inch thick. The film of gas, while virtually friction free, is under pressure that is stiffer than the steel ball bearings it replaces. At the same time, vibration, or bearing noise, is decreased by a ratio of 30 to 1.

Although the principle of the gas bearing is not new, previous models without ceramics have been severely limited due to size and bearing wear caused by starting and stopping.

The new gyro is only 2.817 inches long and 2.0 inches in diameter and weighs only ½ pound. In tests, its super-hard ceramic bearings have undergone many thousands of starts and stops without detectible wear.

In addition to nearly eliminating the drift caused by the ball bearings, drift caused by the instability of other critical gyro parts has been reduced considerably by using ceramics in the spin motor and gimbal constructions.

Even such exotic gyro materials as beryllium have undesirable 'characteristics that can cause gyro drift, engineers explained. In stability tests of its new ceramics, the material was subjected to temperatures ranging from —85 F to 1,500 F and the material retained its original dimensions within 2 millionths of an inch.

The ceramic material is so rugged that it is cleaned in hydrochloric acid to remove submicroscopic particles that could affect gyro performance. The acid dissolves everything but the ceramic, permitting cleaning and assembly techniques in production substatially better than the conventional use of cleaning solvents and ultrasonic scrubbing.

Ceramic gyro parts are rough cast in powdered form. The material can be worked easily in the half-fired "green" state. After final firing at 3,200 F, the material becomes as hard as sapphire.

While the ceramic is harder than ordinary grinding wheel materials, it can be finish-ground with diamond compounds to extreme accuracy and excellent surface finish. Tolerances on some parts of the new gyro are being held to less than 3 millionths of an inch.

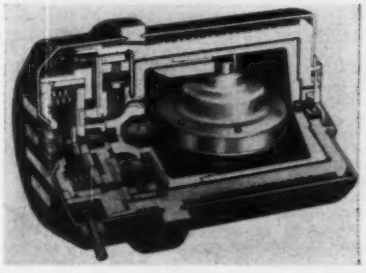
The company has been conducting research in the field of close tolerance ceramics for several years and recently began full-scale commerical production of precision ceramic components for military and industrial applications.

Honeywell described the ceramic gas bearing unit as the next generation in a family of gyros that began with the miniature integrating gyroscope (MIG). The MIG is presently used in guidance systems on a number of today's missile and space programs.

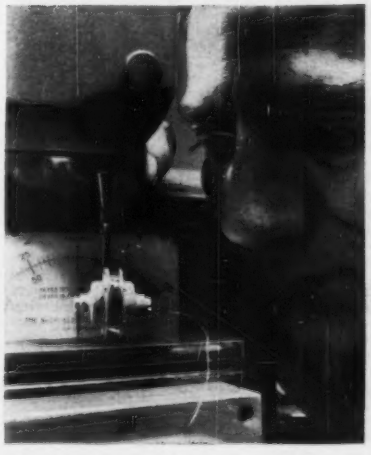
Like the MIG, the gimbal of the new gyro is floated to reduce friction torque. Flotation of the gimbal weight to better than 99% has reduced friction to the order of a million times less than ball bearings.

This torque level, it was pointed out, is approximately what is developed by shining a flashlight on a playing card that is hinged on one edge. (light exerts pressure).

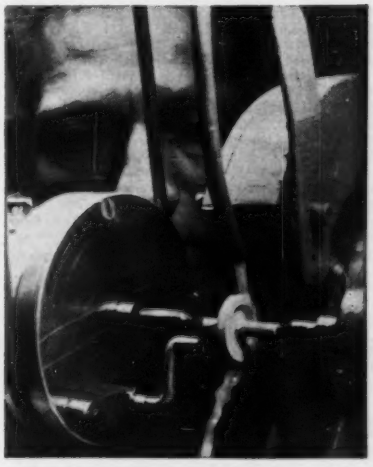
The MIG, and now its successor, the ceramic gas bearing gyro, were designed for applications such as missile guidance. The new gyro, despite its extreme sensitivity, is virtually impervious to the acceleration, vibration, pressure and temperature changes encountered in missiles and space vehicles. **EE**



CUTAWAY DRAWING shows the complexity of a new gas bearing gyroscope introduced by Minneapolis-Honeywell. The bell-shaped part in the cavity of the gyro is the ceramic spin motor. Its interior spins at 24,000 rpm suspended on a film of helium gas only 25 millionths of an inch thick. The 8-ounce gyro is 2.8 inches long and 2.0 inches in diameter.



ELECTRONIC equipment that measures in millionths of inches is used to check tolerances on a spin motor that is the heart of the ceramic gas bearing gyroscope. Ceramic parts used in the gyro's miniature gas bearing are machined with diamond grinding wheels to tolerances within 5 millionths of an inch.



CERAMIC rotor and shaft of the miniature gas bearing gyroscope are honed to a tolerance of within five millionths of an inch. The diamond grinding wheel shown here has the only surface hard enough to shape the sapphire-hard ceramic material. The shaft is inserted into a bearing with only 25 millionths of an inch clearance.

NEW BOOKS

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

ANALOG COMPUTATION. By A. S. Jackson. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1960. 652 pages, 6¼ by 9¼ inches, bound. $13.50. This college-level text does not require a specialized electronics background. Its general purpose is an appreciation of systems analysis, and the value of analog computation in comparison with analytical and numerical procedures. The subjects covered are: basic analog computer concepts, elements and components available, design philosophy and operating characteristics; magnitude and time scaling; solution of statistical problems and mathematical models; simulation of system adjoints; operational amplifier design problems; and detailed examples and representative applications, including combined digital-analog computations.

ELECTRONIC ENGINEER'S REFERENCE BOOK. Edited by L. E. C. Hughes. Second edition. The Macmillan Company, 60 Fifth Ave., New York 11, N. Y., 1959. 1588 pages, 5 by 7½ inches, bound. $18. This revision comes close on the heels of the first edition, published in 1958, but it has been revised and has 350 additional pages. Included are new sections on nondestructive testing, components, radiation detection, digital computer applications, simulators, and electronic telephone exchanges.

ELSEVIER'S TELECOMMUNICATION DICTIONARY. Compiled and arranged by A. Visser. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N. J., 1960. 1011 pages, 6¼ by 9 inches, bound. $27.50. This is a polyglot dictionary with a basic list of 9,928 numbered terms in English with their equivalents in Dutch, French, German, Italian, and Spanish, and thumb-indexed lists in each of these five languages keyed to it. While both British and U. S. terms are included, the former seem to be emphasized.

ESTIMATOR'S ELECTRICAL MAN-HOUR MANUAL. By J. S. Page and J. G. Nation. Gulf Publishing Company, 3301 Buffalo Dr., Houston, Texas, 1959. 219 pages, 7 by 9¼ inches, bound. $10. This is a collection of tables, based on an analysis of shop and field studies yielding an average productivity rate of 70%, which give manhours required for the installation of all types of electric equipment. Labor time for indoor and outdoor domestic and industrial jobs for power and lighting, for machinery installation, underground ducts and cables, communication and signal systems, and necessary demolition and excavation, are included.

FIXED AND VARIABLE CAPACITORS. By G. W. A. Dummer and H. M. Nordenberg. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1960. 288 pages, 6¼ by 9¼ inches, bound. $10. Part one of this book is a general discussion of the historical development, fundamental concepts, characteristics, and selection of capacitors, and the measurement of capacitance. The remaining two sections deal in turn with fixed and with variable capacitors, mainly U. S. military types, supplemented where necessary by commercial parts. Some European parts are mentioned, and both U. S. and British specifications, symbols, values, and color codes are given. Capacitors of paper, mica, ceramics, glass and vitreous enamel, electrolytic, vacuum, or gas or air filled, for general purpose, precision, trimmer, transmitter, and other uses are included.

AN INTRODUCTION TO STATISTICAL COMMUNICATION THEORY. By D. Middleton. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1960. 1140 pages, 6½ by 9¼ inches, bound. $25. This is a graduate-level exposition of the application of modern statistical methods to random phenomena such as messages, signals, and noise, that influence and control the design, operation, and evaluation of communication systems. It deals specifically with electronic and electric systems such as radio and radar, but the general methods and philosophy are applicable in other areas of communication science.

IONIZATION PHENOMENA IN GASES. By Gordon Francis. Academic Press, Inc., 111 Fifth Ave., New York 3, N. Y., 1960. 300 pages, 5¾ by 8¾ inches, bound. $10.50. This graduate-level text complements others by concentrating on those discharges not previously treated collectively. The first two chapters provide a general background in describing the nucleus, ionization, and excitation of the atom, spectra, conduction of electricity in a gas, and the fundamental processes of ionization and deionization. The remaining chapters discuss the similarity principle as applied to discharges, alternating, high-current and high-frequency discharges, thermonuclear effects, ionization in the upper atmosphere, and plasma oscillations and waves. Periodic tables, critical potentials, and physical constants are included in appendices.

OVERVOLTAGE RESEARCH AND GEOPHYSICAL APPLICATIONS. Edited by J. R. Wait. Pergamon Press, Inc., 122 E. 55th St., New York 22, N. Y., 1959. 158 pages, 6½ by 9¼ inches, bound. $9. Here are the results of a concerted effort to apply the overvoltage (or induced electrical polarization) phenomenon to geophysical prospecting, based on theoretical and experimental research done at Newmont Mining Company laboratories. This monograph deals in turn with the basic concept of overvoltage, a mathematical description of the phenomena, phenomenological theory, laboratory results, and analyses of experimental data. Extensive field results are presented based on surveys in various parts of the world.

PLASMA PHYSICS. By J. G. Linhart. Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N. Y., 1960. 278 pages, 6¼ by 9 inches, bound. $7. This graduate-level summary of current plasma physics describes the behavior of plasmas first by the analysis of a single particle and then by using the fluid model. These two models of description are then applied to plasma processes such as equilibrium configurations, wave-motion, instabilities and shocks, motion of plasma bunches, and the various collision, diffusion, and radiation processes operative in arriving at equilibrium. Finally, some of the applications of plasma physics to the research on the controlled fusion of light nuclei, to electronics, and to other problems in applied physics and engineering are described.

PROCEEDINGS OF THE SYMPOSIUM ON MILLIMETER WAVES. (MICROWAVE RESEARCH INSTITUTE SYMPOSIA SERIES, vol. IX). Sponsored by the Polytechnic Institute of Brooklyn. Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N. Y., 1960. 656 pages, 6 by 9 inches, bound. $8. The 40 papers here published include 9 not presented at the symposium. Participating were scientists from England, France, Japan, Israel, the Netherlands, the USSR, and the U. S. The papers discuss the present state of the use of millimeter waves in such fields as physics, communication, solid-state research, and metallurgy; dielectric, power, and electron profile measurements; the generation of millimeter and submillimeter waves by undulator, Cerenkov, and Purcell radiation, as well as by other means; multimodes and components; and future trends and applications of millimeter wave research.

PROGRESS IN SEMICONDUCTORS, Volume 4. Edited by A. F. Gibson and others. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1960. 291 pages, 6¼ by 9¼ inches, bound. $10.50. This fourth volume in the series contains papers from the Soviet Union, England, Germany, Holland, Japan, and the United States. The scope of the discussions is shown by the titles of the papers: negative effective masses in semiconductors; oxidation phenomena on germanium surface; theory of avalanche multiplication in nonpolar semiconductors; internal field emission; noise in semiconductors; the electrical effects of dislocations in semiconductors; dielectric properties of solids in relation to imperfections; noncrystalline, amorphous, and liquid electronic semiconductors.

A SIMPLE APPROACH TO ELECTRONIC COMPUTERS. By E. H. W. Hersee. Blackie and Sons, Ltd., London, England, 1959. 104 pages, 5 by 7½ inches, bound. £0.12.6. The author presents in detail but simply, a few of the working principles of both digital and analog machines. For the former, he includes number representation, basic circuits, input and output control, and some special-purpose computers; and for the analog computer, elementary ideas, basic circuits, and the solution of a simple problem using this machine.

SYMPOSIUM ON RADIOISOTOPES IN METALS ANALYSIS AND TESTING. Published as Special Technical Publication No. 261 by the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., 1960. 62 pages, 6¼ by 9¼ inches, bound. $2.75. Four survey papers discuss general types of analysis using radioisotopes, such as thickness gaging, absorptiometry, radiometry, activation and isotope dilution assays, and the proper instrumentation for these methods. The remaining four papers describe current industrial activity, including the analysis of tungsten and of aluminum for trace impurities, and the training of personnel in the utilization of radioisotopes.

UNITS, DIMENSIONS, AND DIMENSIONLESS NUMBERS. By D. C. Ipsen. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1960. 236 pages, 6 x 8¾ inches, bound. $6.50. This discussion of the concept of units and dimensions emphasizes theory, introducing techniques as the systematic application of theory. The nature of physical ideas and relations, the physical and mathematical nature of units, conversion, similitude, and the units and dimensions of mechanics, thermodynamics, and electricity are described, and the final chapters discuss dimentionless numbers, geometrically dissimilar systems, and the techniques of dimensional analysis.

HIGH VOLTAGE CIRCUIT-BREAKERS. By Vladislav Zajic. Constable & Company Ltd., London, England, 1957. 324 pages, 6 by 8 inches, bound. £1.5.0. This translation from the Czech begins with a detailed examination of basic principles, definitions, and historical development, and continues with a thorough analysis of the high-voltage system from the standpoint of circuit-breaking. The major section surveys eight types of high-voltage circuit breakers, giving characteristic features and detailed design and construction information. The final section discusses methods of test.

PHYSIQUE NUCLÉAIRE APPLIQUÉE. By Robert Guillien. Éditions Eyrolles, Paris, France, 1960. 663 pages, 6¼ by 9¾ inches, bound. NF 85.10. The author has gathered material on the procedures and applications of nuclear science from many sources into a fundamental and concise treatise on the basic elements. He writes on the structure of matter and of electricity, on the particles involved in nuclear phenomena, and on the instruments for detecting some of their characteristics. The latter half of the book deals with nuclear reactions, radioisotopes, and nuclear reactors and their uses. The French atomic effort is outlined in the final chapter.

HYDROMAGNETIC CHANNEL FLOWS. By L. P. Harris. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1960. 90 pages, 6¼ by 9¼ inches, bound. $2.75. This book presents analyses for three flows of viscous, incompressible, electrically conducting fluids in high-aspect-ratio rectangular channels subjected to transverse magnetic fields, using methods based on hydromagnetic equations, dimensional analysis, and experiment. Principal results of this study include a scheme for correlating experimental friction-factor data and methods for computing mean-velocity profiles, mean magnetic-field distortion, current distributions, and turbulent-shear distributions in the d-c turbulent flow.

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MATRICES. By W. V. Parker and J. C. Eaves. The Ronald Press Company, 15 E. 26th St., New York 10, N. Y., 1960. 195 pages, 6¼ by 9¼ inches, bound. $7.50. An introductory college-level development of the theory of matrices. After a review of elementary mathematical concepts, the theory is introduced through linear forms and systems of equations with a complete matrix treatment. The theory of determinants is made to depend on the theory of matrices. Also included are discussions of row and column transformations, equivalence and rank, elementwise and blockwise operations, partitioning, and the MURT technique.

INTRODUCTION TO MATRIX ANALYSIS. By Richard Bellman. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1960. 328 pages, 6¼ by 9¼ inches, bound. $10. Symmetric matrices and quadratic forms, matrices and differential equations, and positive matrices and their use in probability theory and mathematical economics, each are discussed in this book from the standpoint of their mathematical, physical and economic backgrounds. Emphasized are those parts of each theory that occur in analysis and application, particularly applications in digital computer solutions of differential equations, dynamic programming, and stoichiastic processes.

MOTOR SELECTION AND APPLICATION. By C. C. Libby. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1960. 508 pages, 6¼ by 9¼ inches, bound. $13.50. Based on ASA, AIEE, and NEMA standards, and written to guide those responsible for the selection, application, and maintenance of electric motors for industrial use, this book describes motor selection in terms of load characteristics, service requirements, space limitations, duty-cycle requirements, and safety. Motor temperature rise is discussed in relation to motor insulation, motor temperature, and various load cycles. The book also covers load torque characteristics for induction, synchronous, and d-c motors, and demonstrates the relation of load variables to motor characteristics. Motor enclosures as protection for all types of industrial motors are analyzed. Preventive maintenance and compensating mechanical arrangements for changing loads are also covered.

NONLINEAR ELECTRICAL NETWORKS. By W. L. Hughes. The Ronald Press Company, 15 E. 26th St., New York 10, N. Y., 1960. 313 pages, 6¼ by 9¼ inches, bound. $10. Discussion of the general characteristics of nonlinear elements is followed by sections on pertinent mathematical methods, and simple nonlinear circuits with and without energy-storage elements. Steady-state and transient analyses of complex networks are then studied, followed by chapters on nonlinear network stability, phase-plane methods, oscillations, and subharmonics.

NUCLEAR FUSION. Edited by W. P. Allis. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N. J., 1960. 488 pages, 6¼ by 9¼ inches, bound. $12.50. An edited and subject-indexed selection from the papers on fusion presented at the 1958 Geneva Conference on Peaceful Uses of Atomic Energy. The book has three major sections: survey papers, general plasma properties, and thermonuclear machines.

ARTIFICIAL EARTH SATELLITES. Edited by L. V. Kurnosova. Plenum Press, Inc., 227 W. 17th St., New York 11, N. Y., 1960. Two volumes in one, 6 by 9½ inches, bound. $9.50. Translation of information on the results of the Soviet Union's first three earth satellites. Separate papers include the data obtained in orbit, discussing methods of observation, cosmic-ray measurements, upper atmosphere and electron density, orbit parameters and other areas of upper atmosphere research. Volume 1 includes space biology and data on Laika, the first astronaut. Volume 2 includes discussion of similar investigations carried out with rockets.

PROGRESS IN NON-DESTRUCTIVE TESTING, Volume 1. Edited by E. G. Stanford and J. H. Fearon. The Macmillan Company, 60 Fifth Ave., New York 11, N. Y., 1959. 267 pages, 6¼ by 10 inches, bound. $12. The first of an annual series containing international critical reviews of any type of nondestructive measurement carried out on solids, liquids, and gases, with the object of examining some aspect of their physical, chemical, or biological condition. Included in this volume are discussions of industrial and neutron radiography and ultrasonic inspection, as well as application of electromagnetic, thermal conductivity, and nuclear magnetic resonance techniques.

QUANTUM ELECTRONICS. Edited by C. H. Townes. Columbia University Press, New York 27, N. Y., 1960. 606 pages, 6¼ by 9½ inches, bound. $15. These are advanced papers from seven nations, fully one third of which deal with masers, their properties, types, and uses such as in amplification, pumping, time standards, spectroscopy, and millimeter wave generation. Other topics discussed include relaxation processes and methods, paramagnetism, electromagnetic amplification, molecular beams, and atomic clocks.

SCHOTZE UND SCHOTZENSTEUERUNGEN. By Herbert Franken. Springer-Verlag, Berlin, West Germany, 1959. 382 pages, 6½ by 9½ inches, bound. DM 42. This is a treatise on contactors, covering basic principles, behavior under abnormal conditions, and the great variety of control devices and protective equipment utilizing contactors. Separate chapters are devoted to special types, durability, selection criteria, control methods, signal equipment, and test methods. There is an extensive bibliography including a scattering of English references.

SERVOMECHANISM PRACTICE. By W. R. Ahrendt and C. J. Savant. Second edition. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1960. 566 pages, 6¼ by 9¼ inches, bound. $12.50. The numerous methods of achieving the essential functions of servomechanism components are described in this text, and the problems associated with the operation of servos and their components, and design, manufacturing, and testing techniques are discussed. Emphasis is placed on the practical aspects of servo components, circuits, and systems, but theoretical data and both root locus and frequency response stability methods are included.

SOLID STATE PHYSICS IN ELECTRONICS AND TELECOMMUNICATIONS, Volume I: SEMICONDUCTORS, Part 1. Edited by M. Désirant and J. L. Michiels. Academic Press, Inc., 111 Fifth Ave., New York 3, N. Y., 1960. 638 pages, 6¼ by 10 inches, bound. $18. Dr. Shockley introduces this first volume on semiconductors by surveying the development and potential of solid-state electronics. More than 60 papers then discuss semiconductor preparations, properties and noise, surface phenomena of pertinent materials, solid-state theory, and the effect of intense electric fields in semiconductors. About one third of the papers are in French or German. No index.

SYMPOSIUM ON ELECTRON METALLOGRAPHY. Published as ASTM Special Technical Publication No. 262 by the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., 1960. 128 pages, 6 by 9 inches, bound. $4.25. This volume includes papers on the electron metallography of cast nickel, tin alloys and tin plate alloy layers, dislocations, high-temperature alloys with special attention to their phase morphology, and steels including the structural effects of neutron irradiation. Other papers discuss electron diffraction techniques and electron microprobe measurements.

THEORY OF ELEMENTARY PARTICLES. By Paul Roman. Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N. Y., 1960. 575 pages, 6¼ by 9 inches, bound. $12. This is a general review of the fundamental theoretical aspects of elementary particle research. It includes the necessary mathematical background, the basic concept of a particle field, the principal concepts of quantum field theory, and subjects of current interest such as symmetry properties and conservation rules, space inversion, time reflection, particle-antiparticle conjugation, and questions relating to isospin.

APPLICATIONS OF THERMOELECTRICITY. By H. J. Goldsmid. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1960. 118 pages, 4¼ by 6¾ inches, bound. $2.25. This is an elementary account of the applications of thermoelectricity in semiconductors and the uses of the Peltier effect for refrigeration. The theory of thermoelectricity is outlined; the thermoelectric properties of semiconductors, selection of semiconductors, properties of semiconductor alloys, the preparation and evaluation of materials for conductivity, and thermoelectric generation comprise the rest of the book.

AN INTRODUCTION TO THE PHYSICS OF MASS LENGTH AND TIME. By Norman Feather. Quadrangle Books, Inc., 119 West Lake St., Chicago 1, Ill., 1959. 358 pages, 5¾ by 8¾ inches, bound. $5. From the basis of an historical account of the emergence of the concepts of the measurements of mass, length, and time, the author develops the whole subject of the mechanical properties of matter in bulk. Calculus is completely excluded in order to concentrate on the understanding of principles rather than mathematical facility. This is a nonspecialist explanation of physics, and of the general methodology of science and the reasons for its success.

BIOLOGICAL AND MEDICAL ELECTRONICS. By R. W. Stacy. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1960. 308 pages, 5¾ by 8¾ inches, bound. $9.50. Opening with discussion of the theoretical concepts of instruments, including frequency response characteristics, this book covers all recent advances in the use of modern electronic apparatus for biological and medical research. Application of these concepts is given in descriptions of currently available equipment in standard use, and sections on transistors, computers, shielding, troubleshooting, and assembly of instrument schemes.

COLLOQUE SUR LA DIFFUSION À L'ÉTAT SOLIDE, 1958. (SYMPOSIUM ON SOLID STATE DIFFUSION). Published by the Centre d'Études Nucléaires de Saclay, Saclay, France, 1959. 175 pages, 8½ by 11 inches, bound. $6.25. Some 21 specialized papers comprise this symposium. Specific types of diffusion investigated are chromium in titanium, metals in thin metallic films, helium in metals, oxygen in zirconium, uranium-titanium, hydrogen in iron, etc. Other topics include methods of measuring diffusion, energy of solution of rare gases in metals, and investigations of brittleness, ionization, preferential location, etc., as diffusion phenomena. Only three papers are in English but all have English summaries.

COMPUTER HANDBOOK, 1960. Published by the Instruments Publishing Company, Inc., 845 Ridge Ave., Pittsburgh 12, Pa., 1960. 76 pages, 8½ by 11¼ inches, paper. No price given. The analog section of this collection of papers includes discussion of the EDA, simulation, computer reliability, and new techniques and mathematical elements for computation. The digital section covers the DDA, control, natural-gas-dispatching, and solid-state process computers, the digiverter, digital printing, desk calculators and other small and medium-sized computers.

CONNECTING INDUCTION MOTORS. By A. M. Dudley and S. F. Henderson. Fourth edition. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1960. 425 pages, 6¼ by 9¼ inches, bound. $13.50. In presenting both the theoretical and practi-

cal side of single-phase and polyphase induction motor windings and operation, the author explains how input as electric power is converted to mechanical power, and gives a picture of the rotating magnetic field. The influence of changing voltage, phases, and frequency, and such variations in winding as turns per coil, coil throw, winding distribution, and type of connection are all related to corresponding motor performance. This edition includes new information on part-winding starting connections, single-phase connections, multispeed polyphase motors, and the use of performance characteristics information on the motor name plate for optimum utilization of the motor.

ELECTRICAL AND ELECTRONIC DRAWING. By C. J. Baer. McGraw-Hill Book Company, 330 W. 42nd St., New York 36, N. Y., 1960. 218 pages, 6¼ by 9¼ inches, bound. $6. The purpose of this book is to survey the entire field, including reference to current standards, symbology, and practice, illustrating the text by means of the drawings of experienced professionals. Of the five types of drawings postulated by the author, detailed treatment is given pictorial drawings, and wiring, block, and schematic diagrams, while standard engineering or production drawings are only selectively covered. Electronic circuits and devices receive much emphasis.

THE ELECTROLYTIC AND CHEMICAL POLISHING OF METALS IN RESEARCH AND INDUSTRY. By W. J. McG. Tegart. Second edition. Pergamon Press, Inc., 122 E. 55th St., New York 22, N. Y., 1959. 139 pages, 5¾ by 8¾ inches, bound. $6.50. A survey of both metallurgical techniques and industrial finishing operations, describing the apparatus, methods, and limitations of each process. This revision emphasizes laboratory work, but includes fuller discussion of the nature of mechanically prepared surfaces and of commercial electropolishing units.

ELECTROMAGNETIC THEORY AND ENGINEERING APPLICATIONS. By J. B. Walsh. The Ronald Press Company, 15 E. 26th St., New York 10, N. Y., 1960. 286 pages, 6¼ by 9¼ inches, bound. $8.50. This book presents the essentials of field theory and their application to distribution-parameter circuits, particularly transmission lines. It includes discussion of vector analysis, electrostatics, static magnetic fields, Maxwell's equations, and transmission lines.

TECHNICAL LITERATURE

The following recently issued technical literature may be of interest to readers of *Electrical Engineering*. All inquiries should be addressed to the issuers.

STATISTICAL HANDBOOK OF SCIENCE EDUCATION (NSF—60-13) Published by the National Science Foundation, this compilation should prove to be a useful reference work for anyone interested in the education and training of scientists and engineers in the United States. The major parts of the publication deal first with human resources data, second with institutional and financial data, and third with general appendix tables containing more detailed information on all these subjects. Much of the information is presented in graph form, with accompanying tabular matter to aid those needing more exact statistics. Copies may be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., at a price of 55¢.

CONTROLLED RECTIFIER MANUAL. This new design manual for applying silicon controlled rectifiers (SCR) in electronic and electric equipment contains information on voltage transients in SCR circuits, test circuits, turn-off characteristics of the device and methods, firing characteristics and firing circuits, and series and parallel operation of SCR's. In addition, there are chapters on protecting the SCR against overloads and faults, typical circuits operating from a-c power, the device's basic theory of operation and its ratings and characteristics. 224 circuit diagrams, charts, monographs, and oscilloscope traces are included. Copies for $1 each are available from General Electric Company, Department SCR, Charles Bldg., Liverpool, N.Y.

NEMA STANDARDS. *CP 1-1960 Shunt Capacitors.* Capacitor units ½ kva and larger for power factor improvement and other low-frequency a-c applications and assemblies of capacitor units with accessories and control to form complete capacitor installations are covered in this revised edition. Price 50¢ per copy. *HU1-1960 Industrial Heating Units and Devices* covers cartridge, tubular, strip, immersion, and tubular-type water-immersion heaters. The section dealing with cartridge heaters has been revised and expanded to include dimension nomenclature, sheath length, and wattage rating. 30¢ per copy. *SG 6-1960 Power Switching Equipment* gives information concerning the rating, performance testing and application of the following types of power switching equipment: air and interrupter switches, bus supports, accessories, and outdoor stations. The terms used are defined, and instructions are given for the installation, operation, and care of equipment. Price is $3 per copy. These standards are available from National Electrical Manufacturers Association, 155 E. 44th St., New York 17, N.Y.

AMERICAN STANDARDS. A revision of *American Standard Specification for Dry Cells and Batteries* has been published as Handbook 71. Designated *C18.1-1959*, it includes new tests, up-to-date data, performance requirements, and covers new types of dry cells. Batteries for use with transistors are included for the first time. The dry cells and batteries have a nonspillable electrolyte. The price is 25¢ per copy. *American Standard Specifications for Fluorescent Lamp Ballasts, C82.1-1960* has been approved and published. In this revision of *C82.1-1958*, the two major revisions are: changes in the minimum light tolerance for certain rapid start lamps, and the inclusion for the first time of 1.5-ampere rapid-start lamp ballasts. It is available for 80¢ per copy. The uniformity and electrical characteristics for specific rapid-start fluorescent lamps are covered in the following three standards of which two are revisions and a third is new: *American Standard C78.701-1959* sets down the dimentional and electrical characteristics of 72-inch (800- and 1,000-milliampere) T-12 Rapid-Start Fluorescent Lamps. This standard is a revision and consolidation of *C78.701-1956* and *C78.703-1958*. *American Standard C78.702-1959* covers the same characteristics of 96-inch (800-milliampere) T-12 Rapid-Start Fluorescent Lamps. This is a revision of American Standard *C78.702-1958*. The new standard *C78.707-1959* similarly treats 96-inch (1.5-ampere) T-12 and PG-17 Rapid-Start Fluorescent Lamps. All three standards are divided into four categories: lamp designation, dimentional characteristics, operating characteristics, and starting requirements. They are priced 35¢ each. All of the above mentioned standards may be ordered from the American Standards Association, 10 E. 40th St., New York 16, N.Y.

ASTM STANDARDS. *Electrical Insulating Liquids and Gases D-27* is the first single-volume compilation of ASTM (American Society for Testing Materials) standards for liquid electrical insulating materials. Typical of the standards are: Test for Cloud and Pour Points; Tests for Interfacial Tension of Oil against Water; Tests for Corrosive Sulfur in Electrical Insulating Oils; Tests for Scavenger content in Askarels, and Recommended Practice for Safe Use of Oxygen, Combustion Bombs. Price $4.25 each. *Metallic Electrical Conductors B-1* supersedes the 1957 edition containing 59 standards of which 3 are completely new, and 36 are revised or have had their status recently changed. The new standards are for bare aluminum wire for electric conductors, for aluminum coated steel core wire, and for testing electrical conductivity by use of eddy current. Price $4.50 per copy. Both volumes may be ordered from ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

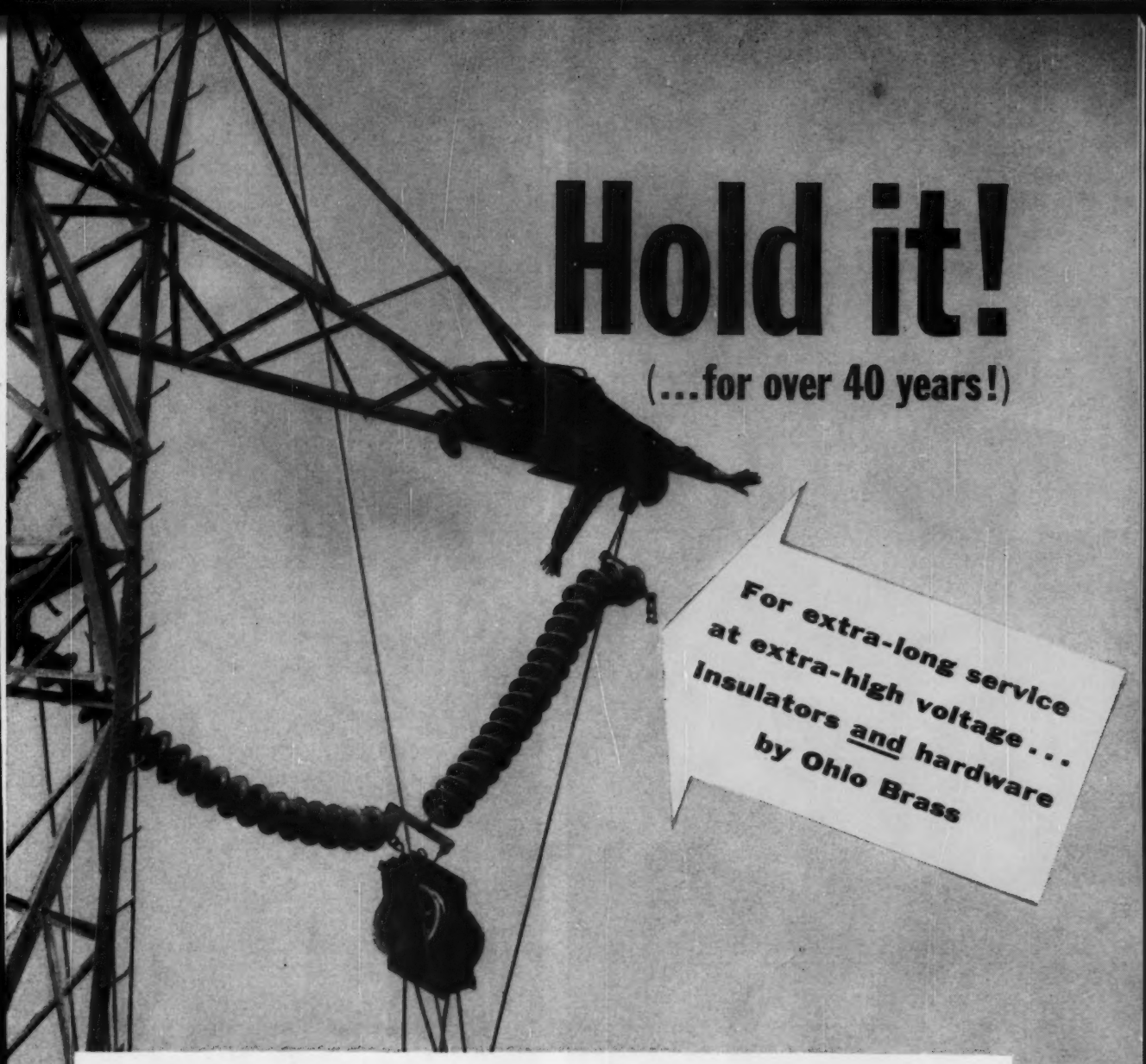
NEC PROCEEDINGS, Volume 15. This book contains all the technical papers and addresses presented at the 1959 National Electronics Conference (NEC). The 109 technical papers cover electronic research, development, and application of antennas, circuits, communications, computers, electron tubes, engineering management, instrumentation, magnetic amplifiers, materials and communication, microwave, radar, servomechanisms, solid-state devices, parametric amplifiers, and engineering writing and speech. Copies of the volume are available from National Electronics Conference, Inc., Room 2104, North LaSalle St., Chicago 1, Ill.; price $10.

INFORMATION PROCESSING. Proceedings of the UNESCO International Conference held in June 1959 on information processing are now available in a 600-page volume. The conference was attended by 2,000 experts from 39 countries under the presidency of Dr. Howard Aiken of Harvard. The contents are: Methods of Digital Computing, Common Symbolic Language for Computers, Automatic Translation of Languages, Pattern Recognition and Machine Learning, Logical Design for Computers, Computer Techniques of the Future. Apart from subject index and index of authors' names, it contains the full text and summaries of each of the 61 papers discussed at the conference. Priced at $25, the volume may be obtained from UNESCO Publications Center, 801 Third Ave., New York 22, N.Y.

IAEA PUBLICATIONS. *Directory of Nuclear Reactors Volume I: Power Reactors* gives all basic data on power recators in operation or construction in member states, including most valuable unpublished data. Price $3.50. *Volume II: Research, Test and Experimental Reactors* presents comprehensive information on these reactors and is invaluable for reactor designers, constructors, engineers, scientists, universities, etc. Price $3.50. *Nuclear Electronics Volumes I and II* contains proceedings of the "Colloque international sur l'Electronique nucléaire," Paris, September 1958. Papers are recorded in author's language, in English or French. Price $4. *International Directory of Radioisotopes. Volume I: Unprocessed and Processed Radioisotope preparations and Special Radiation Sources.* Price $3.50. *Volume II: Labelled Compounds.* Price $3. These publications may be ordered from National Agency for International Publications, Inc., 801 Third Ave., New York 22, N.Y. or in most overseas countries from International Atomic Energy Agency local sales agents.

PROCEEDINGS OF THE SECOND INTERNATIONAL ANALOG COMPUTATION MEETINGS. These proceedings of a meeting held in Strasbourg in September 1958 have been published in a 501-page book including 545 figures and 45 tables. The contents are: Electronic Analog Computers; Analog, Mechanical, and Electro-Mechanical Computers; Rheoelectric Analog Computers; Analog Computers with Electric Networks; Special Computers; Analog-Digital Connections; General Applications; Methods of Computation and Mathematical Reports. The volume may be ordered from Presses Academiques Europeennes, S. C., 98, chaussee de Charleroi, Brussels 6, Belgium. The price is $22.

FOOTCANDLE LEVELS AND INTERIOR LIGHTING DESIGN. Included in this 60-page pocket-size manual are recommended footcandles for a myriad of industrial, commercial, and residential applications, information on distribution and light measurements, and precalculated footcandle tables. It contains information on coefficients of utilization and maintenance factors, together with footcandle tables, for various types of luminaries and light sources, data on fluorescent, incandescent, and mercury vapor lamps, and information on ballast losses. In addition, the booklet contains sections on interior wiring, allowable current-carrying capacities of insulated conductors, information on power factors and line current, and a list of standard wiring symbols. It may be obtained from the Westinghouse Lamp Division Headquarters, P. O. Box 388, Bloomfield, N. J., for 10¢ per copy.



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(...for over 40 years!)

For extra-long service at extra-high voltage... insulators and hardware by Ohio Brass

All suspension insulators and hardware are designed to work together.

But good design is only the beginning. Unless that design is faithfully reproduced in every part of every piece - - porcelain and metal - - the designed strength will never be fully realized.

At Ohio Brass we've been making porcelain for over half a century. We've been making our own metal components - - in our own foundry - - even longer. Here porcelain and metal aren't just designed for each other, they're *made* for each other.

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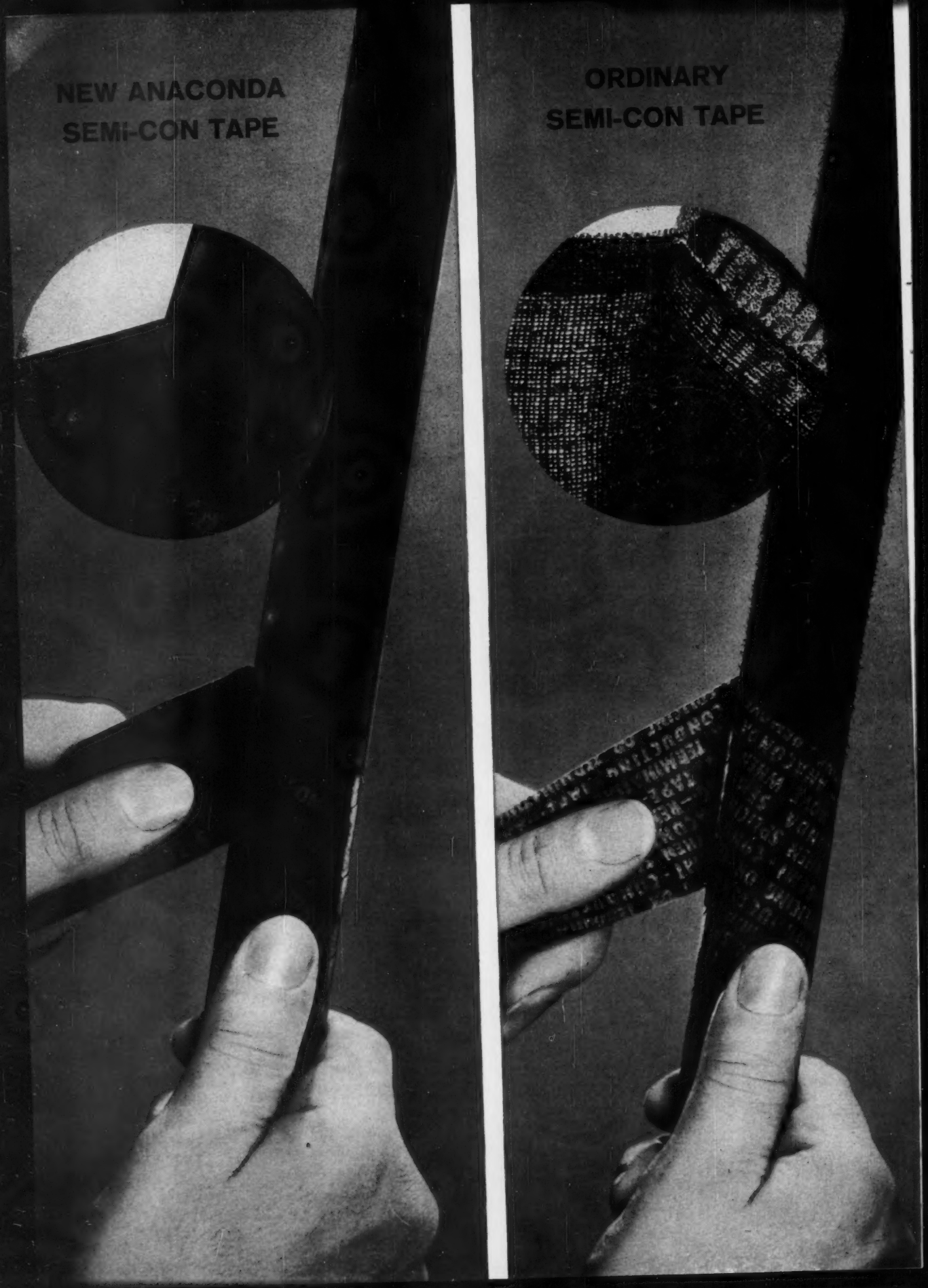

NEW ANACONDA
SEMI-CON TAPE
ORDINARY
SEMI-CON TAPE

NOW YOU CAN GET SAFER, FASTER, MORE RELIABLE JOINTS AND TERMINATIONS ON HIGH-VOLTAGE CABLE

Anaconda Durasheath has a new clean-stripping, semi-conducting tape

PROBLEM: To make a sound, safe, high-voltage splice, every last speck of semi-conducting tape material must be removed from the insulation . . . if traces remain, chances are the joint will eventually fail. But—this important step requires tedious scraping and buffing.

SOLUTION: The new Anaconda-developed *clean*-stripping, semi-con tape*, which is an exclusive feature of Durasheath Cable. The photos (left) were taken immediately after semi-con tapes were stripped off the insulation. It takes much longer to get other cable insulation surfaces as clean. That's why this exclusive feature makes splicing a great deal easier.

The planned research and production program which brings you this outstanding cable development is also responsible for the equally important developments in Butyl rubber insulation compounding and extruding—which have produced the best possible balanced design and construction in high-voltage rubber-insulated cable obtainable today – Anaconda Durasheath.

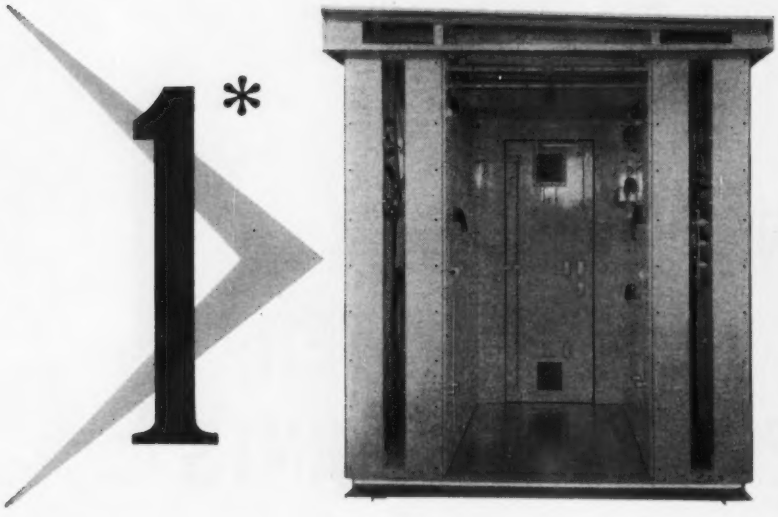
For additional, more technical information about Anaconda Durasheath, write for Anaconda Bulletins, DM-5903, covering Durasheath High-Voltage Cable, and DM's-5566, -5720 and -5735, dealing with the splicing and terminating of Durasheath Cable. Contact your nearest Anaconda Wire & Cable Company district office, or write to 25 Broadway, New York 4, N. Y.

*Pat. applied for 60239 Rev.

ASK THE MAN FROM

ANACONDA®

FOR DURASHEATH® CABLE



*1 — that's right, *just one.* It's the only one of its kind because it was tailor made by Nelson for a major utility company for a specific purpose. It is, however, a good example of Nelson's "Controlled Power Package" which includes motor control centers, low voltage switchgear, high voltage starters, supervisory and special control, and other equipment in a single weatherproof structure, all interwired, ready to hook up to line and load.

This approach means important savings because Nelson takes on the detailed engineering required for coordination and interconnection, and also eliminates the necessity of engineering a separate building. You spend your money where it counts—on the electrical equipment.

This new approach to customer service again confirms the fact that Nelson is

BIG ENOUGH TO PERFORM
SMALL ENOUGH TO CARE

Be sure to let your Nelson representative figure your next job. You will find him listed in the Yellow Pages of major city telephone directories.

NELSON *Electric* MANUFACTURING CO.
TULSA, OKLAHOMA

P. O. BOX 5385 NATIONAL 7-5530

New & Improved Products

(Continued from page 18)

Solid-State Supervisory Control . . .

In 1927, this company developed the first supervisory equipment for control of remote electric apparatus. Today, this company introduces a solid-state system that will take the place of the relays formerly used. As a result, this latest development will provide significant reductions in weight, size maintenance, and power requirements. Designed for operation on any 2-way communication channel, the apparatus uses the GE space-code system and is functionally compatible with conventional relay equipment. *General Electric Co., Section 513, Schenectady 5, N. Y.*

Radio Hearing Aid Link . . .

The smallest and shortest range radio transmitter yet developed allows the wearer of this eyeglass hearing aid to remove his glasses without also having to detach or remove the ear piece. The tiny 1-milliwatt transmitter located in the bow and the equally tiny receiver in the earpiece form a radio link between the two. Because the transmitting distance is limited to less than ½ inch, and frequencies are below the commercial broadcast band, the new hearing aid has received full Federal Communications Commission clearance. *Telax, Inc., 1633 Eustis Ave., St. Paul, Minn.*

Micromodule Kit . . .

A completely self-contained "do-it-yourself" kit will enable manufacturers and engineers to experiment with microelectric circuitry in their own laboratories, thereby reducing design time from weeks to days. The micromodule is essentially a series of minute, razor-thin ceramic wafers, ⅓ inch on a side, containing tiny capacitors, transistors, resistors, diodes, and other important electronic circuit components. These wafers are then assembled in a wire cage, encapsulated in plastic, and inserted into a conventional printed wiring board. *Radio Corporation of America, 30 Rockefeller Plaza, New York 20, N. Y.*

(Continued on page 30A)

Your NATIONAL brush man showed this electroplater how to double brush life!

CLIFF BROWER

PROBLEM: Rapid brush wear was limiting generator performance.

RECOMMENDATION: "National" Brushes Grade BGX.

RESULTS: Not one commutator has been stoned or turned in five years. Brush wear has been even, with no selective action or overheating—even up to 20% overloads. Brush life has been doubled.

Contact your "National" Brush Man

"National", "N" and Shield Device, and "Union Carbide" are registered trade-marks for products of

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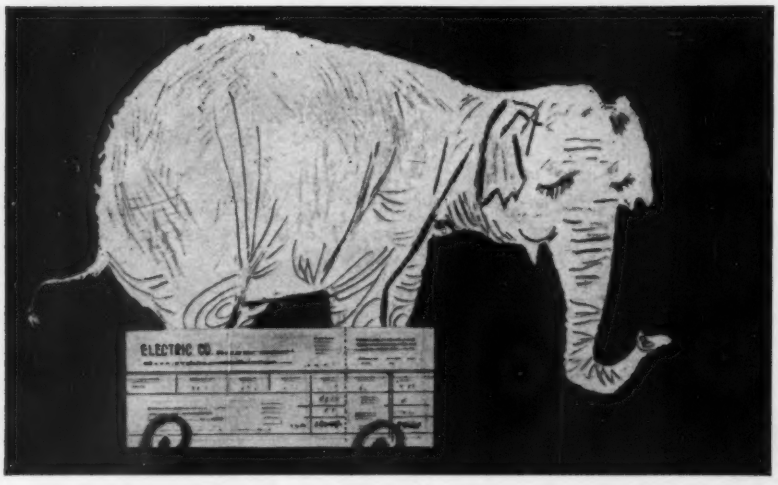
IN CANADA: Union Carbide Canada Limited, Toronto

UNION CARBIDE



THE ABOMINABLE WHITE ELEPHANT ON YOUR ELECTRIC BILL

IF YOUR ELECTRICAL SYSTEM is burdened with a low power factor, you're paying for electricity you can't use . . . you're giving up electrical capacity you may need.

The motors and other inductive devices in your plant use both kilowatts (working current) and kilovars (magnetizing current) in order to run. The kilowatts you buy. The kilovars you can best supply yourself. *The more you supply, the higher your power factor, and the less you pay the electric company.*

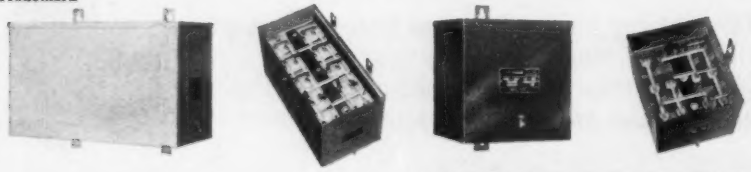
Sprague Unipak* Power Factor Correction Capacitors are the most economical and efficient means of supplying your own kilovars. You put them right where they're needed . . . *at the motors.* Your electric company does not have to send as many kilovars all the way from the power plant, so they charge you less. Your wiring does not have to carry the extra kilovars to the load, so it can handle additional loads.

Actual power bill savings experienced in many plants have more than paid for the Power Factor Capacitors in less than a year's time . . . in some cases, in less than six months. And as an added dividend, these capacitors have also increased the power handling capacity of many plant distribution systems by an average of 20%.

You, too, can reduce costs . . . increase your plant's electrical capacity by installing Sprague Unipak* Power Factor Correction Capacitors. Ask for our handy slide rule calculator which quickly and easily shows the capacitors you need to effect such savings at each load.

Better yet, for *free* assistance in making a complete survey of your electrical installation to see how *much* you can save with Sprague Unipak* Power Factor Capacitors, write Industrial Capacitor Division, Sprague Electric Company, 321 Marshall Street, North Adams, Massachusetts.

*Trademark



WORLD'S LARGEST CAPACITOR MANUFACTURER

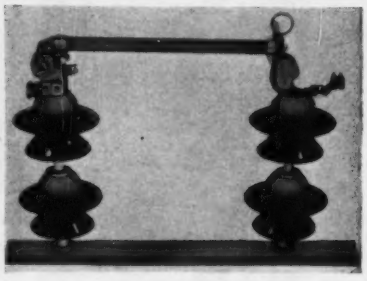
SPRAGUE®
the mark of reliability

New & Improved Products

(Continued from page 28A)

Power Fuses . . .

A new line of power fuses designated *BPA* and *HPA*, offers such operating improvements as Fiberglas fuse holders, improved latching mechanism, provision for easier handling with a



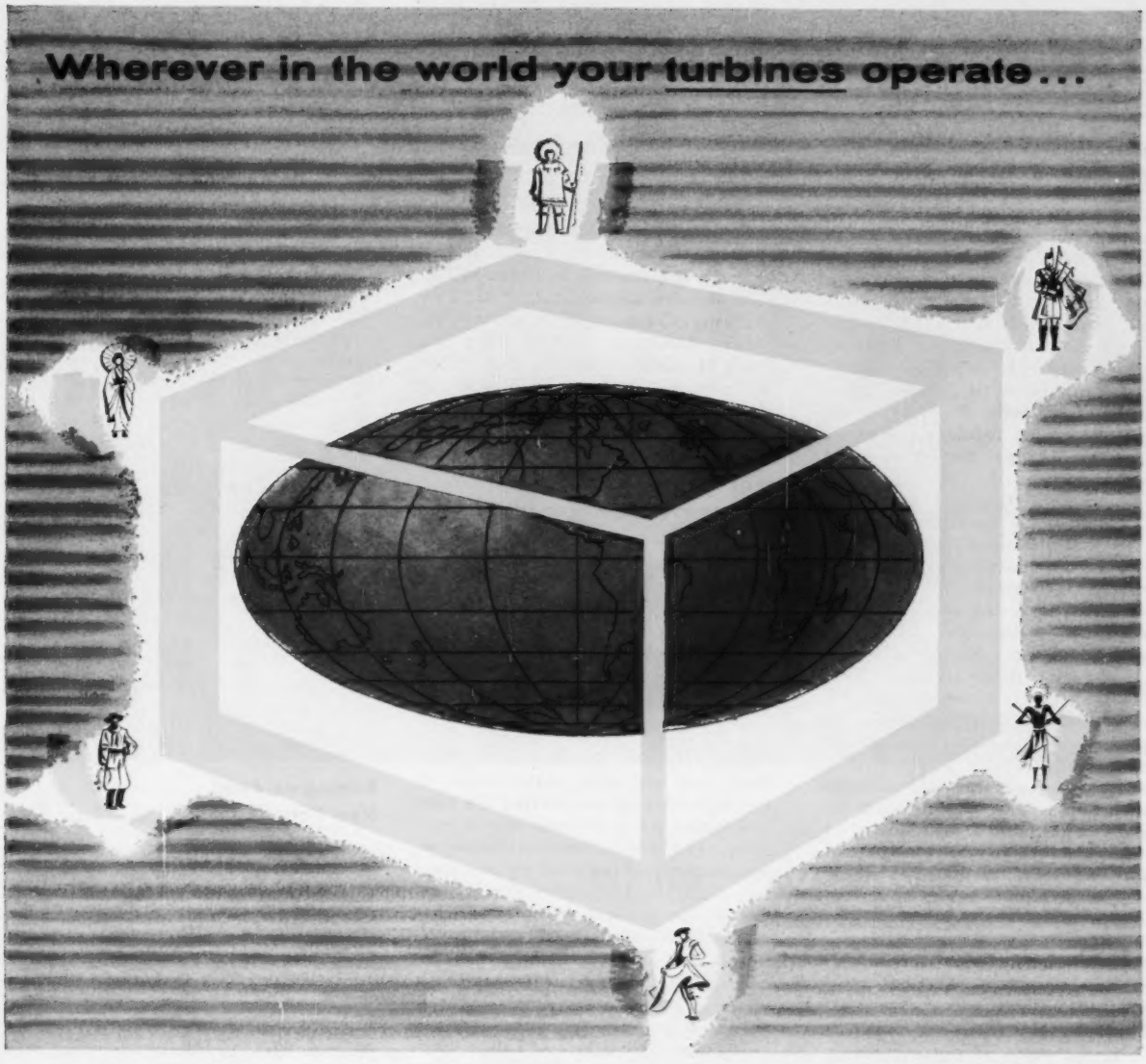
hookstick, and Amplitact contacts to eliminate damage from high, short-circuit currents. Type *BPA* has voltage ratings from 7.2 to 69 kv, continuous ratings of 100 and 200 amperes, interrupting ratings as high as 934,000 kva. Type *HPA* has voltage ratings from 7.2 to 161 kv, continuous ratings of 100, 200, 300, and 400 amperes, and interrupting ratings as high as 3,480,000 kva. *Southern States Equipment Corp., Hampton, Ga.*

Watt-Hour Meter . . .

Two cylindrical Alnico magnets with opposing magnetic fields keep the rotating disk of this newly developed watt-hour meter floating on friction-less lines of magnetic flux. Even when the meter is installed at a considerable degree of tip or tilt, upper and lower cobenium pivots and graphite rings in combination with the magnetic cushion tend to hold the disk accurately in position. *Sangamo Electric Co., Springfield, Ill.*

Mercury Switch . . .

Although this miniature mercury switch was initially developed for a portable motor clutch, it is also ideally suited for such applications as paging devices, and hearing aids, or for use where small space and light switching force become a single-pole single-throw factor. Action is single pole, single throw, and differential angle is 15 degrees. Full capacity is 230 volts at 0.1 ampere. *Gordos Corporation, 250 Glenwood Ave., Bloomfield, N. J.*



Other outstanding Shell Industrial Lubricants available world-wide

Shell Tellus Oils – for hydraulic systems

Shell Alvania Grease – multi-purpose industrial grease

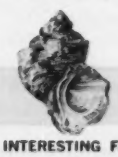
Shell Rimula Oils – for heavy-duty diesel engines

Shell Talona R Oil 40 – anti-wear crankcase oil for diesel locomotives

Shell Dromus Oils – soluble cutting oils for high-production metalworking

Shell Macoma Oils – for extreme pressure industrial gear lubrication

Shell Voluta Oils – for high-speed quenching with maximum stability



AN INTERESTING FACT!
Every Shell Branded Industrial Lubricant is named for a sea shell. Shown here is the Turbo crassus.

Shell Turbo Oil is there

Around the world, Shell Turbo Oil is available—under the same brand name and providing the same outstanding performance. This is assurance that your customers abroad will enjoy the superior turbine lubrication that domestic customers insist upon.

Shell Turbo® Oil provides these 4 outstanding reasons for its acceptance as a top-rated lubricant for utility, industrial and marine turbines: (1) It has exceptional oxidation stability for maximum service life. (2) It separates readily from water. (3) It protects against rust. (4) Its performance does not vary—make-up oil is identical to the original charge regardless of time of purchase.

No matter where your turbines operate, make Shell Turbo Oil your standard recommendation. Write for complete information.

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SHELL

Industrial Notes...

Weston Instruments
Union, N.J. . .

A special 5-day refresher training program for instrument repair technicians has been inaugurated by Weston Instruments Division of Daystrom, Inc. R. R. Vernon will direct the course which will offer instruction in the latest advances in repair work. Keyed for experienced technicians interested in Weston procedures and methods, the training will take place in regular production areas, emphasizing the practical instruction which the technician will find most useful. Intensive training will be offered in the assembly and casing of small instruments such as panel meters. Participants will work with company personnel in calibrating, checking, and casing of large instruments such as switchboard and portable meters. A round-up session of the program will cover areas of specific interest, and information will be supplied on special tools and equipment. Applicants should notify the company at least 2 weeks in advance of the week they wish to begin. Instruction is free, but all other personal charges must be assumed by enrollers. For further information, write: Daystrom, Inc., Weston Instruments Division Repair Service, 2530 Polk St., Union, N. J.

Green Instrument Co.
Cambridge, Mass. . .

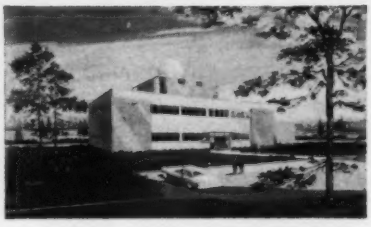
Newly located at 295 Vassar St., Cambridge, Mass., the Green Instrument Company has completed moving the entire plant facilities from their former location at 385 Putnam Ave., Cambridge. The new plant provides efficient single floor layout for effective production speedup and direct platform loading.

General Electric
Syracuse, N.Y. . .

The semiconductor products department of General Electric will add another 260,000 square feet of office, engineering, and manufacturing space to its transistor and tunnel diode facilities. The additional space will make a total of 450,000 square feet in the Syracuse area that General Electric has devoted to the design, manufacture, and sale of transistors and related electronic components.

Consolidated Engineering Co.
Baltimore, Md. . .

A contract for the construction of a 2-story $310,000 building to house experimental radar equipment and a scientific research staff of about 30 has been awarded to the Consolidated Engineering Company by the Applied Physics Laboratory (APL) of The Johns Hopkins University. The building will be used for experimental evaluation of APL-developed search and guidance radar and weapons direction equipment for the Bureau of



Naval Weapons, Department of the Navy, and will serve as the center of the experimental engineering fire control system for a weapons system program. The design and installation of equipment will proceed in co-operation with the Electronics Division of the Westinghouse Corporation, Baltimore. It is expected that the techniques and ideas generated by this experimental system will result directly in significant advances in both time and performance for the prototype model of the APL-developed search and guidance radar. The principal design feature of the new building will be a 3-story central well which will contain experimental portions of the radar. The internal sections of the building will contain the operational subsystems of the radar and weapons direction equipment as well as limited laboratory and office space.

Sprague Electric Co.
North Adams, Mass. . .

The Sprague Electric Company and the Telegraph Condenser Company, Ltd. (TCC) of Great Britain have signed an agreement to exchange research, development, and manufacturing know-how for the next 21 years. Sprague has also sold the rights to its United Kingdom patents and applications to TCC, together with the technical and engineering information necessary to exploit them.

General Electric
Lynchburg, Va. . .

The City of San Francisco, Calif., is installing a 30-channel power-line carrier-current system for the new Hetch Hetchy hydrogenerating project at Cherry Dam in the Sierra Nevada. Built by the General Electric (GE) communication products department at a cost of nearly $100,000, the system uses carrier-current on the 230-kv power lines, providing all the necessary channels for telemetering, load control, transfer-trip relaying, directional-comparison relaying, and supervisory control of switches and circuit breakers, as well as the voice communication for the system's five stations. Almost completely transistorized for maximum reliability of communications, each channel operates independently of the others in the GE system. Many of the channels are spaced only 500 cycles apart, leaving more frequency space available for future growth of the project.

Remington Rand
New York, N.Y. . .

Remington Rand has introduced the Univac III computer system as the newest addition to its line of large-scale electronic computers. A "solid-state" computer, Univac III is described as having a processing speed nine times faster than its predecessor, Univac II, and offering a 25% increase in operating efficiency over present data processing systems. It will rent for $15,000 to $30,000 a month, depending upon the system requirements of the user. A "program interrupt" feature automatically tells the computer when its peripheral equipment has finished a task so that it can instantly be put to work again. The computer can therefore keep all of its associated equipment operating at all times. This has been achieved by using a printed circuit similar to that in Larc, the giant computer designed by Remington Rand for the Atomic Energy Commission. Reading, writing, and computing can be carried on simultaneously, with a reading and writing rate of 200,000 digits a second. Input and output of data is five times faster than with Univac II. Typewriter communication in English can be maintained between the Univac III operator and the computer itself.

(Continued on page 36A)

NOMINAL WEIGHTS OF FINISHED WEATHER-RESISTANT WIRE AND CABLE

(Pounds per 1000 Feet)

Conductor Size AWG or Mcm	Copper & Copper Alloy Conductors				Aluminum Conductors	
	URC Type Double Braid	URC Type Triple Braid	Neoprene Type	Polyethylene Type	Neoprene Type	Polyethylene Type
Stranded						
2	246	270	248	**230**	105	**87.4**
4	155	170	163	**143**	73.3	**53.3**
6	103	115	108	**91.5**	51.5	**35.0**
Solid						
2	239	260	232	**219**	92.2	**79.2**
4	151	164	152	**136**	64.0	**48.0**
6	100	112	101	**87**	45.7	**31.7**

Sources: American Standards Association Specifications

This table shows

POLYETHYLENE covered line wire weighs less

Because it's the lightest, polyethylene-covered line wire is the easiest for linemen to string up . . . hardest for ice and snow loading, gale-force winds to bring down.

Polyethylene-covered line wire, depending on size and conductor, weighs from 5% to 32% less than other types. That's what the figures in the specifications tabulated above show.

This, of course, is no news to linemen who have strung all types of weatherproof line wire. They may not be able to quote pounds and percentages, but they all know you can't beat polyethylene on weight.

Linemen's Favorite Material

Light weight means easy handling, one of the main reasons polyethylene rates tops with installation crews. They also like polyethylene wire because it's clean . . . free-stripping . . . has a smooth, self-lubricating surface that almost makes pulling a pleasure. And despite the exterior slip, the plastic covering hugs the conductor tightly, doesn't ruffle as it goes over crossarms.

"Built-in" Safety Factor

Polyethylene's lightness provides lasting mechanical advantages, since span loads don't tax supports as much as heavier type wire. This "built-in" weight safety factor pays off when violent storms push aerial construction to strain limits . . . when ice and snow loads topple heavier lines.

An added factor in polyethylene wire's ability to stay up under adverse conditions is its smaller diameter. It offers less resistance to wind, a smaller surface for ice build-up.

Winning Combination

Called the "closest to the ideal covering for line wire," polyethylene is outstanding in other respects too. The shield it forms over wire is continuous . . . tough . . . resistant to aging, weathering, moisture, abrasion by lashing branches. It's good for decades of superior service marked by fewer outages, minimum maintenance.

When you order covered wire and cable, make sure the coating is made with PETROTHENE® polyethylene resins. PETROTHENE polyethylene costs no more, but it gives you premium weather and stress-crack resistance.

Polyethylene's advantages are outlined in an informative new U.S.I. data sheet, "Polyethylene . . . The Best Line Wire Covering." Also available is a data sheet showing properties, applications and specifications of PETROTHENE polyethylene compounds. Send for your copies today.

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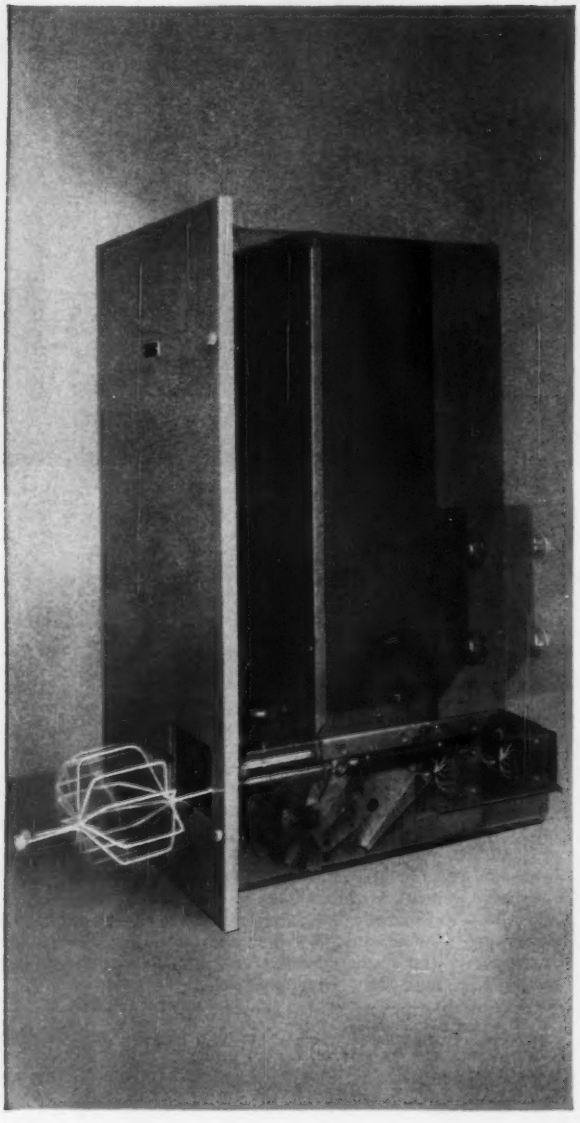
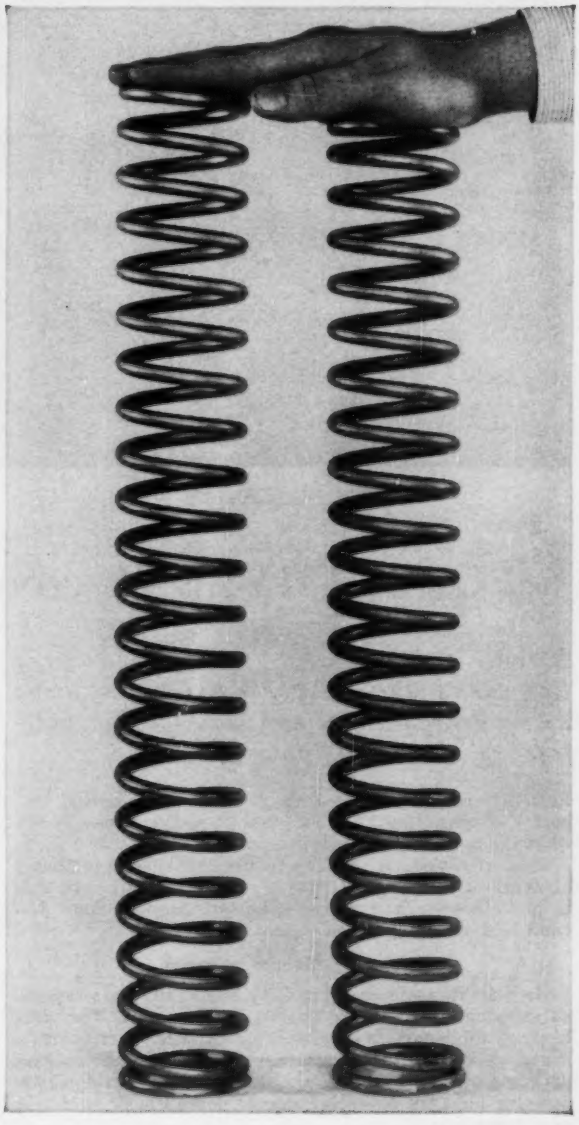


Stored energy as standard . . .



For complete answer, send for new illustrated Bulletin 2801-2A. And ask to see sound strip film that shows you every detail in only 18 minutes. Can be shown to you singly or to your group. Contact your nearby I-T-E sales office. Or write I-T-E Circuit Breaker Company, Dept. SW, 1900 Hamilton St., Phila. 30, Pa.

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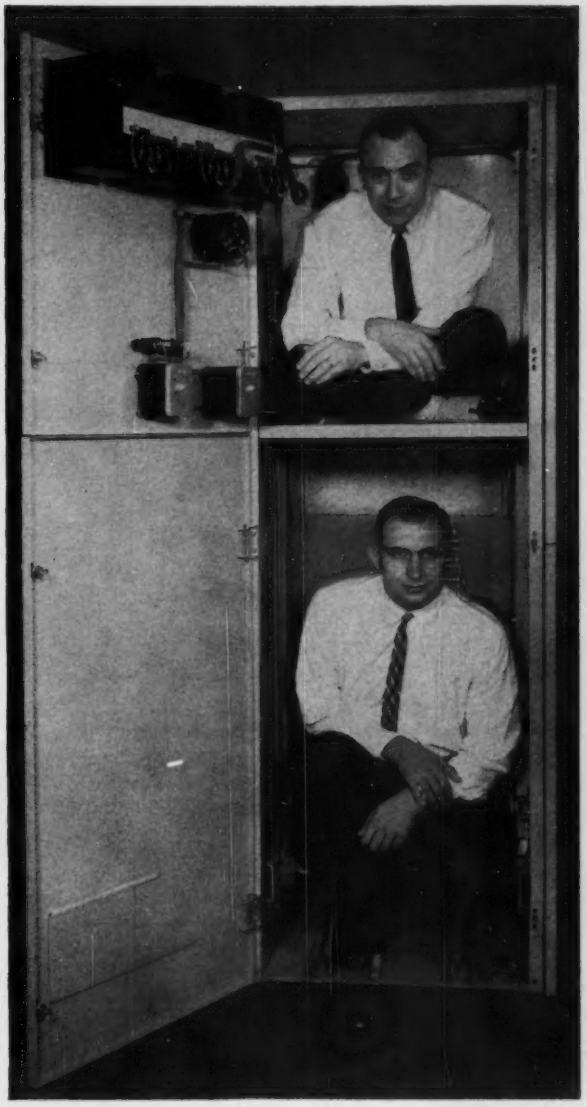
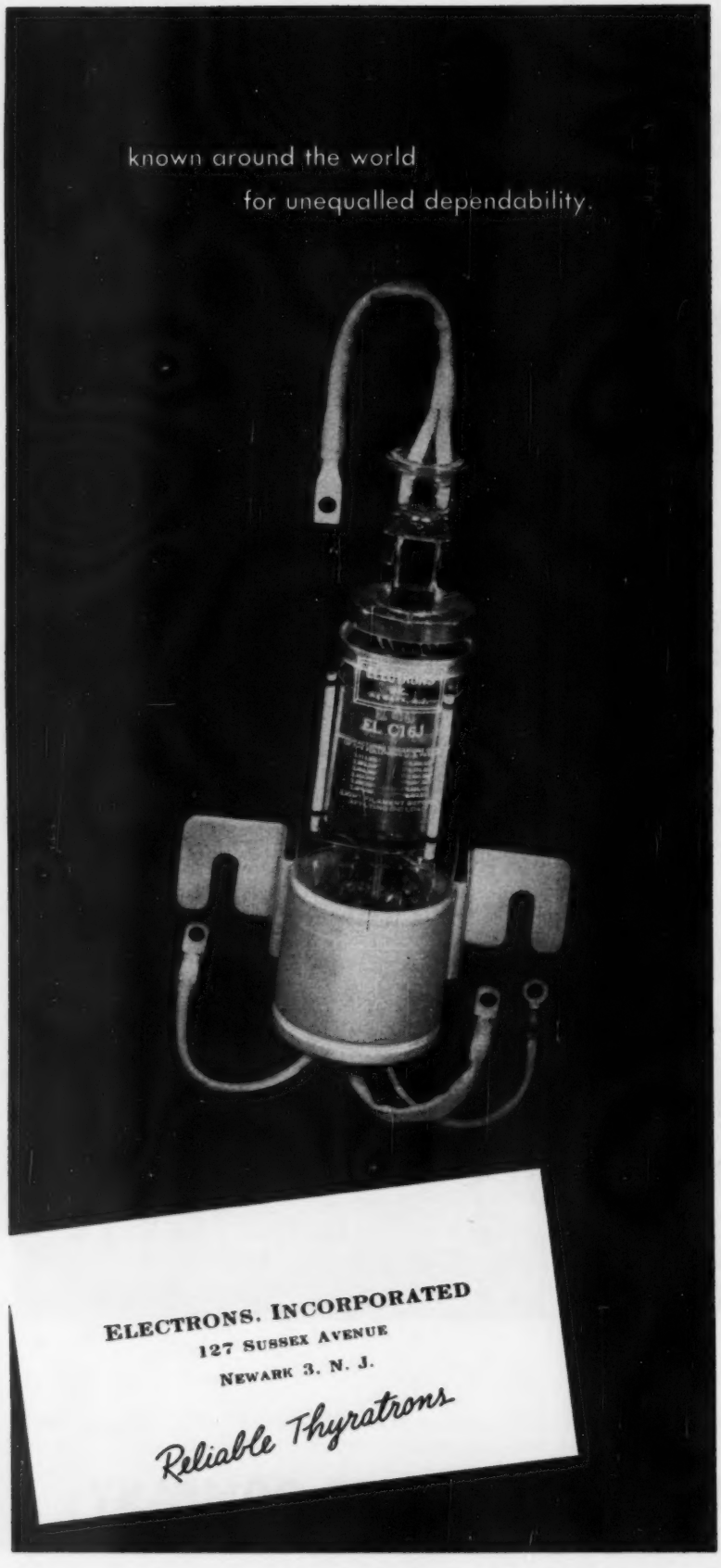
More elbow room inside...



Yet fits in tighter spaces?

I-T-E CIRCUIT BREAKER COMPANY



Industrial Notes

(Continued from page 32A)

Sperry Gyroscope Co. Great Neck, N.Y. . .

A means of greatly extending the speed and altitude limits of lightweight, inexpensive jet engines by combining them with pyrophoric fuel afterburning systems has been announced by Continental Aviation and Engineering Corporation, Detroit, Mich., and Sperry Gyroscope Company, Division of Sperry Rand Corporation, Great Neck, N. Y. Successful tests of unique automatic afterburner controls have enabled engineers to employ with safety these pyrophoric fuels, a group of very fast-burning liquids which ignite on combination with air, in the afterburner of a standard jet engine. The new control system was developed in Sperry's aeronautical engine controls laboratories under contract to Continental. The system is applicable to Continental's J-69 target-missile engines which presently power the Q-2C Firebee pilotless drone. Firebees are used jointly by the U.S. Army, Navy, and Air Force, primarily as targets in tests of the nation's air and missile defenses. The new system already has passed through development and testing stages, including engine qualification endurance testing, and is ready for production as required.

Raytheon Sudbury, Mass. . .

A new Airborne Equipment Center, headquarters for the company's airborne equipment operations, has been completed by Raytheon. The 160,000-square-foot building brings under one roof facilities for manned space vehicle studies, design, development, and torturous testing of advanced airborne electronic equipment. In addition, there are administrative, engineering, and marketing offices. The center houses more than 800 men and women. The building's unique heating system draws heat from the atmosphere, processes it, and distributes it throughout the building, yet requires no fuel. The process is reversed in summer months for air-conditioning. This is New England's first building to incorporate the air-source heat pump principle. Located on Route 20 in Sudbury, Mass., the brick-faced facility was built by Aberthaw Construction Company, and designed by the Engineering Division of Cabot, Cabot and Forbes.

(Continued on page 38A)

NEW DRAW-OUT DESIGN
LIMITAMP* MOTOR CONTROL

DRAW-OUT CONTACTOR

. . . cuts Limitamp control installation time

Rated 2300- to 4600-volts for a-c motors up to 3000 hp.

A draw-out contactor which automatically connects or disconnects as it is rolled in or out of the enclosure!

This is just one of the revolutionary design features in General Electric's new Limitamp motor control . . . a new design which cuts installation time in half!

During installation the contactor is easily withdrawn, leaving ample room to enter the enclosure, pull both motor and incoming power cables and make connections. When cables are connected, barriers are placed in position to seal off incoming line cable and a-c bus. The motor cable—located in its own raceway—is completely accessible when the starter is de-energized.

As the contactor is rolled back in, stab-on contacts automatically plug into the de-energized power circuit. At the same time, control power is automatically engaged. Installation time is held to a minimum.

Ask your G-E Apparatus Sales Engineer about other advanced-design installation, operation, performance and maintenance features of new Limitamp control. Or, write Sect. 783-11, General Electric Co., Schenectady, N. Y. for Bulletin GEA-6893. Industry Control Dept., Salem, Va.

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GENERAL ELECTRIC

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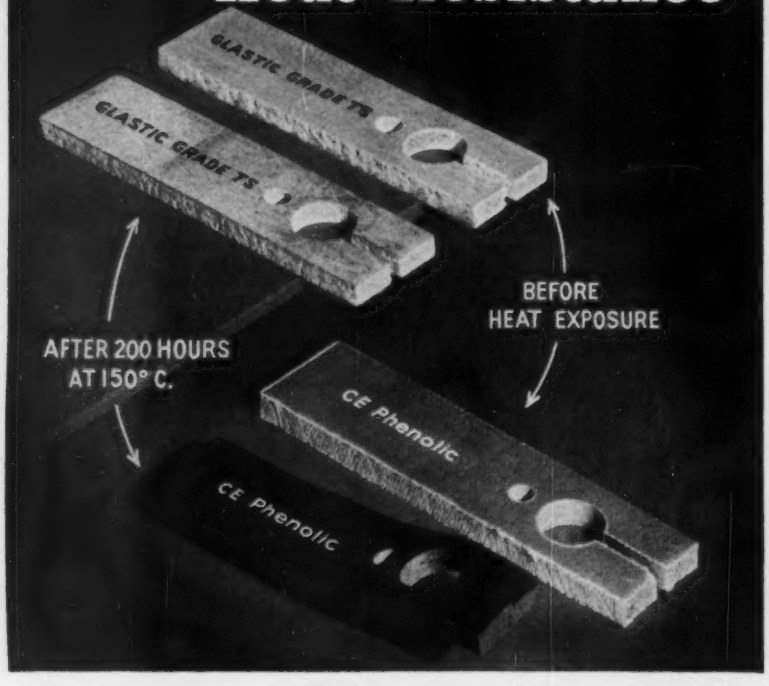
Discover the advantages of GLASTIC®!

Heat Resistance



GLASTIC Class B electrical insulation won't warp or shrink under high heat

Both laminates in the photo were exposed to 150° C. for 200 hours. CE phenolic warped, shrank and became brittle; Glastic Grade TS retained 100% of original planity, 99.92% of original length, and 100% of original impact strength. *All* Glastic laminates are dimensionally stable *during and after* exposure to Class B temperatures (125°—150° C.).

Does this suggest more trouble-free performance and increased value for your product? Or material savings through the use of thinner sections?

Tell us your requirements; Glastic engineers are ready to help you. We'll send free samples for your evaluation. Or write for our new chart that lists 28 thermal, physical and electrical properties of 11 standard Glastic grades.

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THE GLASTIC CORPORATION

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Laminates • Custom Molding • Extruded Shapes • Channel Stock • Insulators

Industrial Notes

(*Continued from page 36A*)

RCA
New York, N.Y. . .

A new high-sensitivity color television camera tube, which makes possible night telecasts in color without special lighting, was used for the first time in Boston, Mass., recently in a regularly scheduled baseball pickup. Cameras equipped with the new tube were used to originate Station WHDV-TV's coverage in color of the night game at Fenway Park between the Boston Red Sox and the Chicago White Sox. Developed by engineers of the Electron Tube Division of Radio Corporation of America (RCA), the new tube requires no greater lighting for colorcasts than that used for black-and-white pickups. Because of its extremely high sensitivity, the tube is expected to reduce substantially power requirements for studio lighting and air conditioning. Designated the RCA-*4401*, the orthicon is directly interchangeable with types *5820*, *6474*, or *7513* in existing cameras. The high-sensitivity image orthicon has been under development for nearly a year at the RCA plant in Lancaster, Pa.

Philco Corp.
Philadelphia, Pa. . .

Philco Corporation has announced the establishment of the equipment development and manufacturing operations as the division's fourth product-marketing group having a full complement of development, engineering, production, and sales functions. The new operations joins the division's long established semiconductor and tube operations, and the recently announced special products operations. The equipment development and manufacturing operations has been commissioned to design, develop, and market specialized fabrication equipment for usage in such industrial areas as semiconductor manufacture, tube manufacture, pharmaceutical and biological processing and metals, chemicals, and foods processing. Products include dry boxes, vacuum ovens, crystal growing furnaces, zone refiners, wafer etchers, scribers, equipment for transistor encapsulation, and measurement systems for usage in missile production. Features will include vacuum equipment for industrial processing where control of dust and atmospheric conditions are necessary, and safety enclosures for handling of dangerous material such as explosives and radioactive elements.

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a New HIGH IN SAFETY AND RELIABILITY!

Only Square D's new combination starters give you all these advantages!

EXTRA SAFETY! • Operating handle permanently attached to switch—eliminates hazard of false handle indication. • Double protection against opening door with switch "ON." • Visible Blades on switch mean safety you can see. • Door must be completely closed before switch can be operated.

REAL RELIABILITY! • Really dust-tight—NEMA 5-12 construction keeps out dust and coolant • Door closes snugly every time—latches at both top and bottom to make tight seal. • Simple closing mechanism—no complicated linkages to get out of adjustment. • Rugged construction throughout for extra-long life.

SO SIMPLE TO USE! • Front operation makes ganging easy. • Plenty of wiring space—all through-wiring with line terminals at top, load terminals at bottom. • Fuse clip-spacing and sizes easily changed to simplify horsepower or voltage change.

***Get the Complete Story** on the newest, safest, most dependable combination starter available*
Write Square D Company, 4041 North Richards Street, Milwaukee 12, Wisconsin

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These items are listings of the Engineering Societies Personnel Service, Inc. This Service, which cooperates with the national societies of Civil, Electrical, Mechanical, Mining, Metallurgical, Petroleum, and Chemical Engineers, is available to all engineers, members and non-members, and is operated on a nonprofit basis. If you are interested in any of these listings, and are not registered, you may apply by letter or resume and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular employment fee of 60% of 1st month's salary, if a non-member, or 50% if a member. Also, that you will agree to sign our placement fee agreement which will be mailed to you immediately, by our office, after receiving your application. In sending applications be sure to list the key and job number.

When making application for a position include eight cents in stamps for forwarding application to the employer and for returning when possible.

A weekly bulletin of engineering positions open is available at a subscription rate of $3.50 per quarter or $12 per annum for members, $4.50 per quarter or $14 per annum for non-members, payable in advance.

POSITIONS AVAILABLE

New York Office

DESIGNER, electrical, experienced in power installation systems for petrochemical plants. Salary, $8500-$9000 a year. Location, New York City. W9257(b).

SUPERVISOR OF ASSEMBLY DEPARTMENT, 30-45, with experience in fine precision assembly in electronics or similar field. Must be able to supervise women. Salary, approximately $7000 a year. Company pays placement fee and moving expenses. Location, suburb of Boston, Mass. W9254.

SALES COORDINATOR, college graduate, preferably with engineering or technical training; 22-35; with two to three years' outside sales experience or production experience in special rotating electrical equipment. Will analyze sales problems, make recommendations and take effective steps to solve it. Salary, $5000-$7000 a year depending on experience, plus fringe benefits. Company will pay placement and moving expenses. Location, New England. W9247.

ELECTRONIC ENGINEERING CONSULTANT, E.E. degree, part time or full time, with minimum of five years' experience in electronic systems and components, to act as liaison and advise technical writers on technical phases and accepted terminology. Salary open. Location, New York City. W9208.

SALES ENGINEER, preferably graduate electrical, with some experience in the sale of electro-mechanical devices, i.e. choppers, power supplies, vibrators, circuit breakers, etc. Salary, $8000 a year plus or minus. Location, East Coast. W9192.

PROFESSOR OR ASSISTANT PROFESSOR, electrical engineering, preferably with an M.S. and three to five years' experience in undergraduate teaching. Salary, to $7200 for nine months. Summer teaching additional. Location, Connecticut. W9184.

SALES ENGINEERS, for marketing of peripheral electronic equipment to be used in electronic data processing industry. Must have strong technical background although degree is not necessary. Must be able to discuss high-speed, analog data handling equipment with engineers, etc. At least two to three years' good selling experience in the E D P industry, preferably with nationally recognized leaders such as IBM, NCR or Burroughs. Some travel. Salary, about $9000 a year and up. Company will pay placement fees. Locations: one for Boston, Massachusetts; one for New York; and one for Washington, D.C. area. W9179.

ELECTRICAL ENGINEER, graduate, 35-50, preferably with P.E. license or eligible, for a firm of consulting engineers engaged in the design and construction of a broad range of technical projects, especially in the power field. Must have eight years of varied experience in electrical engineering, including design, with recent experience in responsible charge of projects in the electrical engineering field or combination of fields such as steam electric generating stations, electric power transmission and distribution systems, relaying, signalling and communications, electrical systems studies and/or theoretical calculations. Salary, to $15,000 a year. Location, Eastern Seaboard. W9178.

TRANSMISSION ENGINEERS with experience in overhead line design or construction derived from electric or communication utilities, cable manufacturers or pole line hardware manufacturers. Location, Ohio. W9167.

ASSISTANT PROFESSOR to teach introductory circuit theory and electronics to electrical engineering students. At least a Master's degree required. Salary, depending upon background and experience, $6200-$8000 on a nine month basis. Location, upstate New York. W9164.

CHIEF QUALITY CONTROL ENGINEER, graduate electrical, plus advanced course in statistical quality control, with a minimum of ten years' quality control and reliability experience in military electronic equipment, to supervise activities of quality control engineers which are: Work with design engineer in selecting components and developing systems to meet government. MIL specification and reliability standards. Work with non-standard electronic components to secure military approval supporting test data. Liaison with government and/or customer on all matters relating to quality control. Salary, about $9000 a year depending upon experience. Location, New Jersey Metropolitan area. W9148.

PUBLICATIONS ENGINEERS, preferably degree in electrical engineering or engineering science, with experience in preparation of technical instruction manuals on military electronics systems such as radar, IFF, electronic displays and data processing. Must be able to gather technical information, organize material and write text. A creative engineering writing position requiring comprehensive understanding of electronic circuitry and military electronic systems together with a strong aptitude and ability for exposition. Salaries, from $6500-$9500 a year depending upon experience. Employer pays placement fees. Locations: New York suburban area and Indiana. W9144.

SALES ENGINEER, graduate electrical preferred, with at least five years' experience selling electrical components. Informal product orientation at plant in Pennsylvania; degree of training dependent upon amount of experience. Salary open. Company will pay placement fee and expenses for interview. Territory, from southern New Jersey to Westchester County, New York; Fairfield County, Connecticut; and all of greater New York and Long Island. W9140.

ELECTRICAL ENGINEERS. (a) Senior Engineers, B.E.E. or B.S. in physics, advanced degree desirable, with a minimum of three to four years' experience in research and development of UHF and/or VHF systems. Wideband background particularly desired. Salary, to $10,400 a year. (b) Engineers, B.E.E., or B.S. in physics, or equivalent, with one to three years' experience as design engineer, preferably with UHF, VHF, IF or heavy pulse. Salary, to $9000 a year. Company pays placement fees and reimburses for interview travel expenses and relocation. Location, New York suburban area. W9139.

ELECTRICAL ENGINEER, graduate, with experience in power distribution and motor control field; marine experience desirable but not a prerequisite; to conduct studies related to power distribution, analysis of tests and test data of power and control equipment to determine adequacy, review of vender plans and technical manuals. Must be U.S. citizen. Location, New England. W9132(a).

SALES ENGINEER, 27-35, graduate mechanical or electrical, with three to five years' sales experience representing a technical product. Familiarity with hydraulics, controls, electronics, servos highly desirable. Recent contacts in aircraft, missiles or control fields also desirable. In-plant training prior to territory assignment. Travel three days per week. Apply by letter giving complete data, including present and expected salary. Company pays placement fee, relocation and interviewing expenses. Headquarters, upstate New York. W9120.

DESIGN ENGINEER, electrical graduate, with from ten to twenty years' experience in the engineering design of electrical systems for petro-chemical plants. Salary, $12,000-$15,000 a year. Location, New York, N. Y. W9114.

Chicago Office

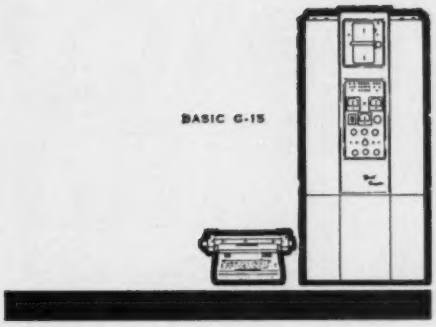
DESIGNER, graduate electrical, to 40; three or more years' experience in open type control transformers, magnetic amplifiers and reactor design. Should also have some practical manufacturing experience on transformers. Must be U.S. citizen. Employer will pay placement fee. Salary, $8000-$15,000 a year depending on experience. Location, Ohio. C8145.

SYSTEMS PLANNING ENGINEER, BSEE, to 45; with ten or more years' experience and a knowledge of utility system planning, economics. Duties: Consulting on electric utility problems in system planning expansion, bulk power facilities and economics associated therewith. Must be able to negotiate at high-executive level; good sales personality for a consulting engineer. Employer will pay placement fee. Salary, $12,000 a year, plus. Location, Chicago. C8013.

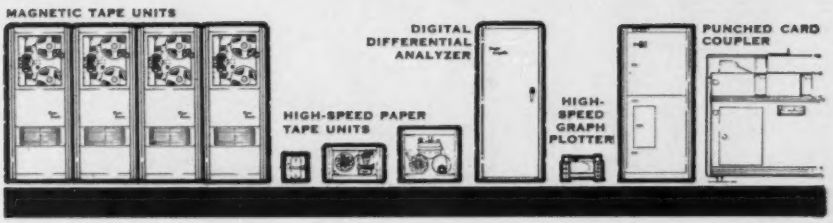
San Francisco Office

INDUSTRIAL SALES ENGINEER, engineering degree, 28-40. Well qualified by recent experience to promote and sell regulators, pneumatic and electronic recorders, transmitters, valves and controllers, pressure temperature and humidity to o.e.m. accounts, processing industries, wholesalers and coinsulting engineer on a non-installed basis. For Seattle, Los Angeles, Portland and Oregon. For a manufacturer. $7200-10,000. S-5362

(Continued on page 42A)



OF ALL LOW-COST COMPUTERS ONLY THE BENDIX G-15 IS PREPARED FOR YOUR **FUTURE**



Before specifying a low-cost computer, ask yourself this question: *"Will the computer be adequate for the future, as well as for our present computing needs?"*

With the Bendix G-15 you don't have to worry about out-growing your computer for years to come. Start with the basic G-15. It comes with every basic element you need...an alphanumeric typewriter, a paper tape punch, and a high-speed photoelectric tape reader. Then, as your computing needs grow and vary, expand your system by selecting from the complete line of accessories illustrated above. Sale or rental prices are extremely low, and performance compares favorably with systems priced many times higher. Write for details.

Bendix Computer Division
DEPT. K-21, LOS ANGELES 45, CALIF.

THE Bendix CORPORATION

(Continued from page 40A)

SALES ENGINEER, engineering degree, age open. Well qualified by current experience to deal with West Coast users of semiconductor base materials. Should know clientele and be thoroughly familiar with marketing and uses of semiconductor materials. For a manufacturer. $12,000 base plus incentive and bonus. West Coast territory. S-5360

CONSTRUCTION SALES ENGINEER. Engineering degree, 28-45. Well qualifiied by experience in contacting architects, contractors, consultants and specifications engineer in private and public business relative to purchase and use of pneumatic and electronic temperature, humidity and air condition controlled systems including regulators, controls, valves and specialty items. Must be able to sell, layout, estimate prices, quote, process and administer a project of substantial size to completion. Personnel needed for Sacramento, Denver, San Francisco, Los Angeles and Seattle. $7200-10,000 plus fringe benefits, profit sharing, car and business expense. S-5351

PLANT ENGINEERING AND PRODUCTION, ME, EE, MetE, 30-50. Seven to twenty years working experience related to ore reduction and milling; one mechanical engineer, one electrical engineer familiar with heavy electrical usage and one metallurgical engineer for production control. Must have seven to twenty years of good solid experience and be familiar with equipment and work in an ore reduction and metals processing plant. Salary commensurate with experience. Nevada. S-5349

OFFICE ENGINEER, EE, under 32. Two to three years experience with consultant or contractor's engineering department on standard light and power for commercial and industrial type installations. Should be able to assist in electrical contractor's type of engineering work, do some board work and assist in estimating, cost, field engineering and client contact under supervision of senior engineer. For an electrical contractor. $125-145 per week depending on experience. Santa Clara County. S-5343

TEST, CHECKING ENGINEER, EE, 21-35. Recent graduate to one to two years experience with aptitude and interest and qualifications to plan and perform electrical testing, technician supervision, production, evaluation and report writing on various electrical products to conform to national standards. Must be able to organize and apply test, independent judgment and carry on personal contact with clients in substantial engineering levels. For a testing laboratory. $480 and up. San Francisco Peninsula. S-5340

(a)CRYSTAL ENGINEER OR PHYSICIST, EE or Physics (solid state). Will design and prototype production of crystals (AT-cut). (b) ELECTRONIC CIRCUIT ENGINEER, EE for crystal filter or crystal circuit development. Should have had three to five years experience in electronic circuitry development. (c) SENIOR ENGINEER, MS or PhD. Network specialist to do research and development work in crystal circuitry. Administrative ability also preferred. Salaries open and commensurate with training and experience. For an aircraft company. Southern California. S-5334-R

FIELD AND OFFICE ENGINEER. Electrical engineer or substantial electrical engineering background, under 30. Some familiarity with electrical construction and installation plans, specifications and methods. Train for ten weeks in Eastern headquarters, return to inspection work related to fire insurance. For a district office. Some Northern California travel. San Francisco headquarters. Car required. About $6000. S-5333

INSTRUCTOR, at least BS EE and preferably experience in electronics industry, especially in circuitry. To teach basic electronic courses and advanced electronic laboratory. About $7000/nine months. San Francisco. S-5324

ENGINEERING MANAGER, EE, with at least six years electrical utility experience, to manage engineering department of small, rapidly growing utility. $13,000-$15,000. Alaska. S-5321

DESIGNER, EE or equivalent, age open. Minimum five years application and systems design of instrumentation for chemical or petroleum plants. Should be able to provide complete design function with minimum supervision. For a consulting engineer. $7-9000. Los Angeles. S-5312

SALES ESTIMATOR, should have good knowledge of fundamentals of motor design and application. Desire familiarity with manufacturing of motors. To work with sales department, determine costs, design requirements, assist in customer contact. Salary open (to $10,200 for good man). For a missile and aircraft industry. San Francisco Peninsula. S-5301

SENIOR CIRCUIT DESIGNER, MS preferred, 26-40. Minimum five to ten years complex circuit design, especially on military type equipment including servos and other related components; half of which should be concerned with transistorized circuitry for electronic systems. For a manufacturer. $10-$12,000. San Francisco Peninsula. S-5298-R

SALES, SENIOR AND MANAGER, Graduate with electronics background, 35-45. Minimum twelve years experience in sales directly to government and major government contractors, knowledge of military contracts; able to build business for major division, supervise other salesmen, plan and budget a sound sales program; must be a producer. For a manufacturer of airborne radar equipment. Employer pays relocation cost and placement fee. $11-13,000. San Francisco Area. S-5296-R

TUNER ENGINEER, EE and advanced study in field of medium, high and very high radio frequency transmission and reception. Two years experience engaged in the product development and design phase of a quality AM and FM broadcast tuner for use in home entertainment systems plus some experience in design of production test equipment and test fixtures for such a tuner. To $900 per month. For a manufacturer of high-quality stereophonic tape recorders and sound system. Employer will pay placement fee. San Francisco Peninsula. S-5296

RESIDENT ENGINEER, Prefer degree in civil engineering or building construction, will consider graduate ME or EE with construction of building structure experience. Minimum six years in engineering and construction experience required, should include at least three years in field supervising construction of manufacturing plants and preferably some supervision of office structures, laboratory buildings or other commercial type developments. One or two years experience in engineering design work such as computations, drawings, estimates and specifications desirable. Job responsibilities would include full responsibility for supervision of contractors' work in construction of sizeable projects in million dollar range or above. To $10,000 per year depending on qualifications and experience. West Coast. Willing to relocate. S-5276

ELECTRONIC DESIGNER, four to five years experience working with inertial equipment. Familiar with system design parameters, service systems and feedback analysis. To design electronic systems for inertial guidance equipment, involving circuit design employing semiconductor components in high-quality amplifiers (AC & DC). Salary open. San Francisco East Bay. S-5221

ELECTRONIC DESIGNER, EE or Electronic Engineer. Solid technical background in designing electronic circuits. Familiar with computer terminology would be helpful. Experience required, one to three years circuit design. To design electronic circuits for computer equipment, such as servo resolvers, amplifiers, preamplifiers, function generators, multipliers and other components. $6000-8400 plus profit sharing bonuses. San Francisco East Bay. S-5219

MEN AVAILABLE

New York Office

SALES MARKETING MANAGEMENT. An electrical engineer who combines extensive and creatively adaptable technical knowledge with the ability to sell. Twelve year's experience in electrical and electro-mechanical products—research, engineering, production market development, sales organization, and sales. Will travel, prefer headquarters in metropolitan New York City area. E-196.

MANAGER, R & D, industrial, teaching and consulting experience in electrical, mechanical and industrial engineering, outstanding record in new product development in several fields. No location preferences. Registered Professional Engineer. E-197.

ELECTRICAL ENGINEER OR ELECTRICAL SUPERINTENDENT, ICS graduate, 29 years' experience in sales, construction and design. Location desired: South or West. E-198.

ELECTRICAL ENGINEER, 34, Canadian, eight years' experience. Construction—Airport, P.O.L. Systems, substations, submarine cables hydro plants in Canada and Asia. Design—substations, distribution, hydro plants including automatic and remote controls and thermal plants. Seeks U.S. or Foreign employment. E-199.

ELECTRICAL ENGINEER, Electrical Designer wiring, Electrical Draftsman; university degree electrical engineer, foreign; 49, with experience in design and construction of substations and generating stations, employed three years' as designer and design draftsman in USA, seeks suitable position in N.W. Texas, Arizona, or New Mexico. E-200.

Chicago Office

RECENT GRADUATE ELECTRICAL, BSEE, 24. Two and half years' experience in substation and power distribution design and applications including shop print handling, correspondence, some specifications, etc. Also two months transmission line tower analysis and checking. Location open. E-1119-Chicago.

TRAINING AND FIELD SERVICE MANAGEMENT, B.A. in Education (math, physics, EE), 31. Seven years' aircraft bomb and navigation systems training and maintenance liaison man for equipment aboard penetration aircraft on Material. Hurricane Hunter Project; maintenance of computer and digital equipment central control, Cape Canaveral. One of technical advisors on highly classified project. Location desired: U.S. and Europe. E-1120-Chicago.

SALES OR PLANNING ENGINEER–ELECTRICAL, BSEE, 28. Over five years' varied experience in sales engineering, project, test and utility planning engineering. Relaying, transmission lines and substations. Registered PE desires work requiring originality. Knowledge of economics and management viewpoint. Location, U.S. or Foreign. E-1121-Chicago.

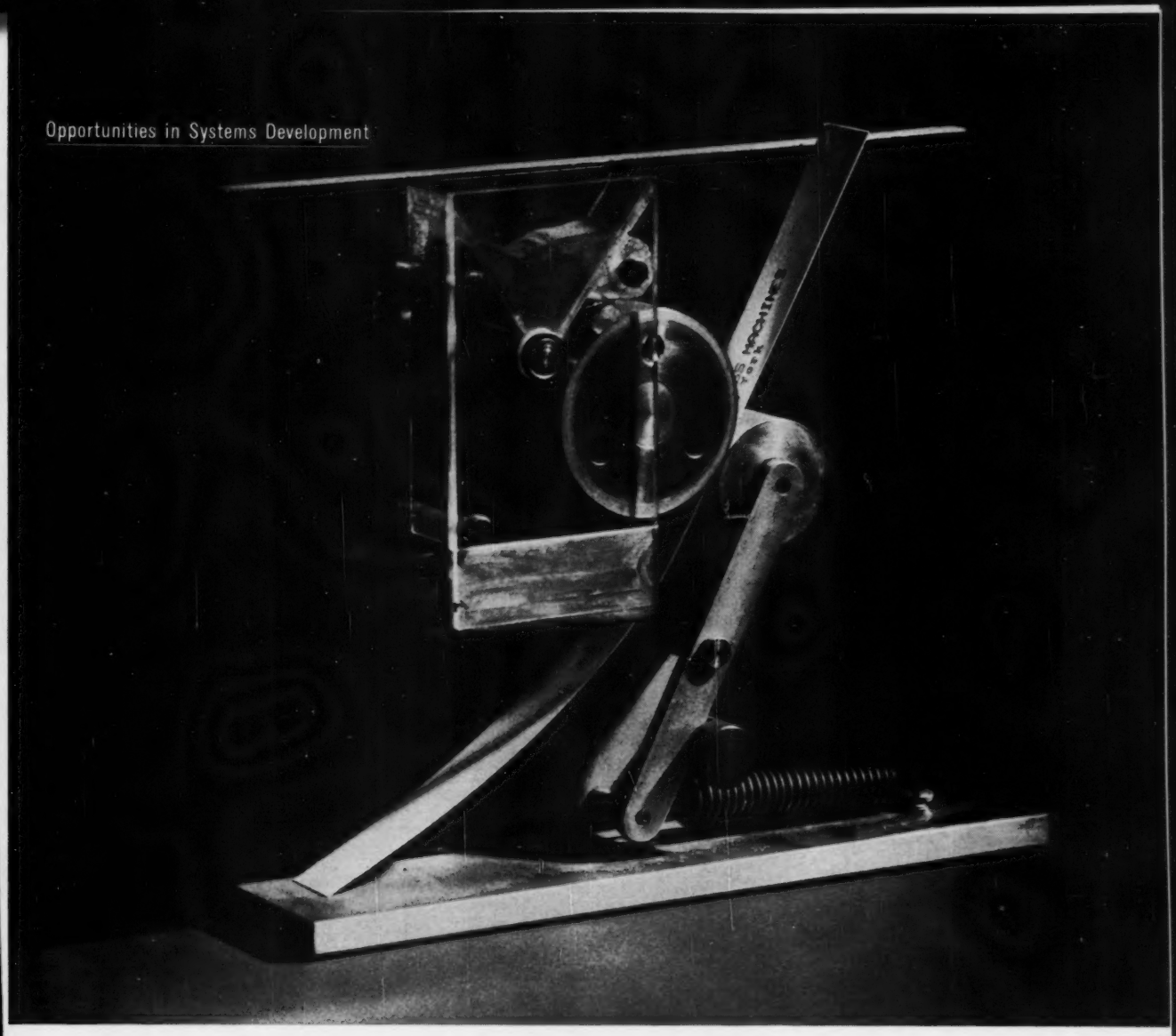
CHIEF ENGINEER, Engineering Manager, Senior Engineer, BSEE, 53. Five years' experience head of engineering design section, ten years designer of DC motors and generators from 5 volt to 750 volts. Six years' testing AC & DC motors and generators, ten years' teaching math, and science in high school, two years' extension instructor for Penn. State Univ. Location desired: Midwest. E-1122-Chicago.

CHIEF ENGINEER OR ENGINEERING MANAGER, BSEE, 42. 15 years' experience design supervision all phases of design and application AC induction motors through 1000 HP. Some DC motors and generators, frequency converters. Engineering standardization, cost control and budget control experience. Location desired: Midwest or West. E-1123-Chicago.

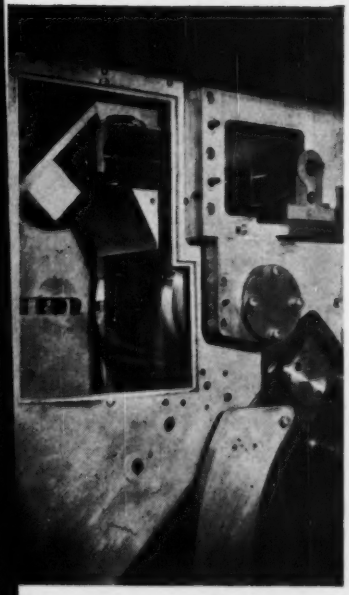
SALES MANAGER PRODUCT ENGINEER, BSEE, registered PE (Mech.), 47. Five years'

(Continued on page 44A)

Opportunities in Systems Development



Bringing to life the principles of magnetic printing



This little hand-cranked model makes practical use of the principles of magnetic printing—principles that have been known in theory for more than a hundred years.

The model represents a big jump from theory to practice. It was developed and built by a group of IBM engineers and scientists brought together for the sole purpose of proving or disproving the feasibility of the magnetic printing process.

These IBM researchers discovered a way to "write" characters on a rotating nickel-cobalt plated drum by casting a magnetic dot image on the drum with time-sequenced electronic pulses. The latent magnetic image attracts and holds powdered iron-resin ink. The ink is transferred to paper and permanently bonded by passage through a heat and pressure fix station.

The machine at left has a working speed of 125 inches per second—equivalent to 1,000 cards a minute. It can be operated for sustained periods at 160 inches per second. A full parallel printer based on these principles is capable of producing many times the output of the fastest IBM impact-type printer.

Engineering Achievement

The magnetic printer project is typical of the many opportunities for achievement awaiting engineers and scientists in advanced systems development at IBM. Perhaps you might be more interested in what IBM people are doing in such areas as: semiconductors, Teleprocessing*, computer development, optics or others. If you have an engineering degree and would like to learn more about these assignments, write, outlining briefly your experience and field of interest, to:

Manager of Technical Employment
IBM Corporation, Dept. 550T
590 Madison Avenue
New York 22, New York

*Trademark

IBM

INTERNATIONAL BUSINESS MACHINES CORPORATION

(Continued from page 42A)

MEN AVAILABLE

sales manager, electro-mechanical components OEM automotive; five years' chief product engineer, electrical components OEM automotive. Ten years' design experience with vehicle manufacturer. Location desired: South, West, Midwest. E-1124-Chicago.

ELECTRICAL ENGINEER, BSEE, registered, 38. Four years' industrial power distribution and control design, one year field supervision for consultant. Four years' industrial survey work, including rate studies, to reduce electrical power costs. Desire multi-plant industrial firm. Location, Midwest or South. E-1127-Chicago.

ELECTRICAL DESIGNER, Industrial Systems or Industrial Equipment, Bachelor of Sc. in E.E., 25. Over three years' experience designing sequential control circuits for automated industrial furnaces, ordering electrical material and laying out drawings for the systems. Also designed some process control including pneumatic and hydraulic control schemes. Location desired: Midwest or West. E-1128-Chicago.

San Francisco Office

ELECTRICAL POWER SYSTEM ENGINEER, MSEE, 53. Registered in California, New York, Oregon and Texas. Wide experience with builders, designers, manufacturers in all types of power system engineering application and supervision; generation, transmission, distribution; planning, reports, design. $14,000. Prefer California. Home: California. Se-1897

DESIGNER, Field Engineer, Physics and Engineering, 56. Thirty-three years experience in consulting, construction, public utilities, industrial power distribution design for public works and private utilities. $12,000-$15,000. Prefer Southern California. Home: California. Se-771

ENGINEERING AID, EE, 20. Some experience in construction field. Wants starting position. Salary open. Prefer San Francisco. Home: California. Se-306

DRAFTSMAN, MAINTENANCE ENGINEER, EE, 29. Five years Naval aviator, collateral duties in administration, personnel, ordnance and aircraft maintenance. $7200. Prefer San Francisco. Home: California. Se-243

JUNIOR ELECTRONIC ENGINEER, Technician, 24, Electronic Engr. Wants starting position as junior engineer, technician or draftsman. $4800. Prefer San Francisco or any location. Home: San Francisco. Se-222.

JUNIOR OR ASSISTANT ELECTRONICS ENGINEER, EE, 23. No experience in this field; willing to take special training or schooling. $5000. Any location. Home: California. Se-182.

MAINTENANCE, INSTALLATION, TEST ENGINEER, EE, 32. Seven years supervising installation of industrial electrical equipment, including steel mill application, generator control boards, switchgear, circuit breakers, transformers; mfr. Two years design, inspection of electrical equipment for Bureau of Reclamation. $7800. Prefer West. Home: Wisconsin. Se-1807.

ELECTRICAL DESIGNER; EE, 37. Professional License in New Jersey. Two years experience design of motor and controls, instruments, waste gas facilities for steel mills, production facilities, power, distribution, ventilation; for chemical plant, manufacturers. Salary open. Prefer San Francisco Bay Area. Home: San Francisco East Bay. Se-1717.

COMMUNICATIONS ENGINEER, EE, 29. Two years plant engineer for small telephone utility, million dollar dial conversion including microwave toll system. Cost studies, feasibility, equipment evaluation, depreciation studies, technical specifications, system design. One year computer field engineer. $7200. Prefer West, U.S. Home: California. Se-1714

DESIGNER, DRAFTSMAN, EE, 26. One year exper. design, draft, light, conduit, layout, power distribution, control design, coordinate electrical and mechanical work; industrial and multistory buildings; consultant. $6000. Any location. Home: San Francisco. Se-1710

DESIGNER, EE (Chile), 38. Two years switchboard design, test engineer for power equipment manufacturer. One year development of high speed vacuum breaker; radio transmitters manufacturer. Three years charge of operation power and light company. Four years maintenance on diesel power plant, machinery. $7000. Prefer California. Home: Texas. Se-1677.

SALES MANAGER, EE, 33. Ten years experience sales of motors, generators, motor controls, application of variable speed drives. $9500. Prefer Los Angeles, West. Home: Wisconsin. Se-1596.

FIELD SERVICE REPRESENTATIVE, Sales, MgtE, 39. (ME trg). Ten years experience field service representative and sales on operation, maintenance, instruction of fire control system, digital computers, radars, for manufacturers, aircraft. Salary open. Prefer West Coast, US., Foreign. Home: California. Se-1534

VICE PRESIDENT, Chief Engineer, MSEE, 45. Twenty-five years in machine tool industry, ten of which in administrative management engineering. $20,000. Prefer Midwest, West. Home: Massachusetts. Se-1530.

CHIEF DESIGNER, BSME, Chem, 48. Five years in charge of design, installation of facilities, process improvement for aluminum and magnesium production and processing. Seven years charge of engineering and research for explosives manufacturer, Six years engineering and negotiations with contractors for government project. Four years design, erection of refinery facility. $10,000. Any location. Home: Washington. Se-1515.

DESIGNER, INSTRUMENTATION, MSEE, 44. Twenty years experience power, chemical, pulp and paper, cement; design, instrumentation, electronics, specifications, field supervision. Capable of handling entire project in all stages. Willing to travel. Registered Professional Engineer, Canada. $9600-12,000. Prefer, San Francisco, West Coast. Home: Canada. Se-1485.

ELECTRIC POWER DESIGN, EE, 55. Twenty-seven years experience on generating and substation design, design for heavy industrial installations. $7400-9000. Any location. Home: Canada. Se-1463.

JUNIOR ELECTRONIC ENGINEER, EE (Electronics), 24. Desire manufacturing, research or development. Military class III-A, married. $6000. Prefer San Francisco Bay Area. Home: California. Se-1314.

RESEARCH AND DEVELOPMENT, EE, 37. Experienced in establishing and maintaining engineering schedule and cost control in electronics, aircraft and missile industries. $13,800. Prefer West, New England. Home: California. Se-1292.

DESIGNER, RESEARCH, EE, 35. Ten years experience design and manufacture of mechanical and electro-mechanical products. Firm background in instrumentation, measurements and switching circuitry. Specialty in mechanical spring design. Speak French, Spanish, Russian and Japanese. $8500. Prefer San Francisco. Home: Illinois. Se-1226.

ELECTRICAL DESIGNER, EE, 51, EE License, California. Over twenty years experience consulting, design, supervising crews on electric switchgear, relaying and controls, construction of refineries, steel mills and process plants. $10,000. Prefer San Francisco Bay Area. Home: San Francisco Peninsula. Se-1169.

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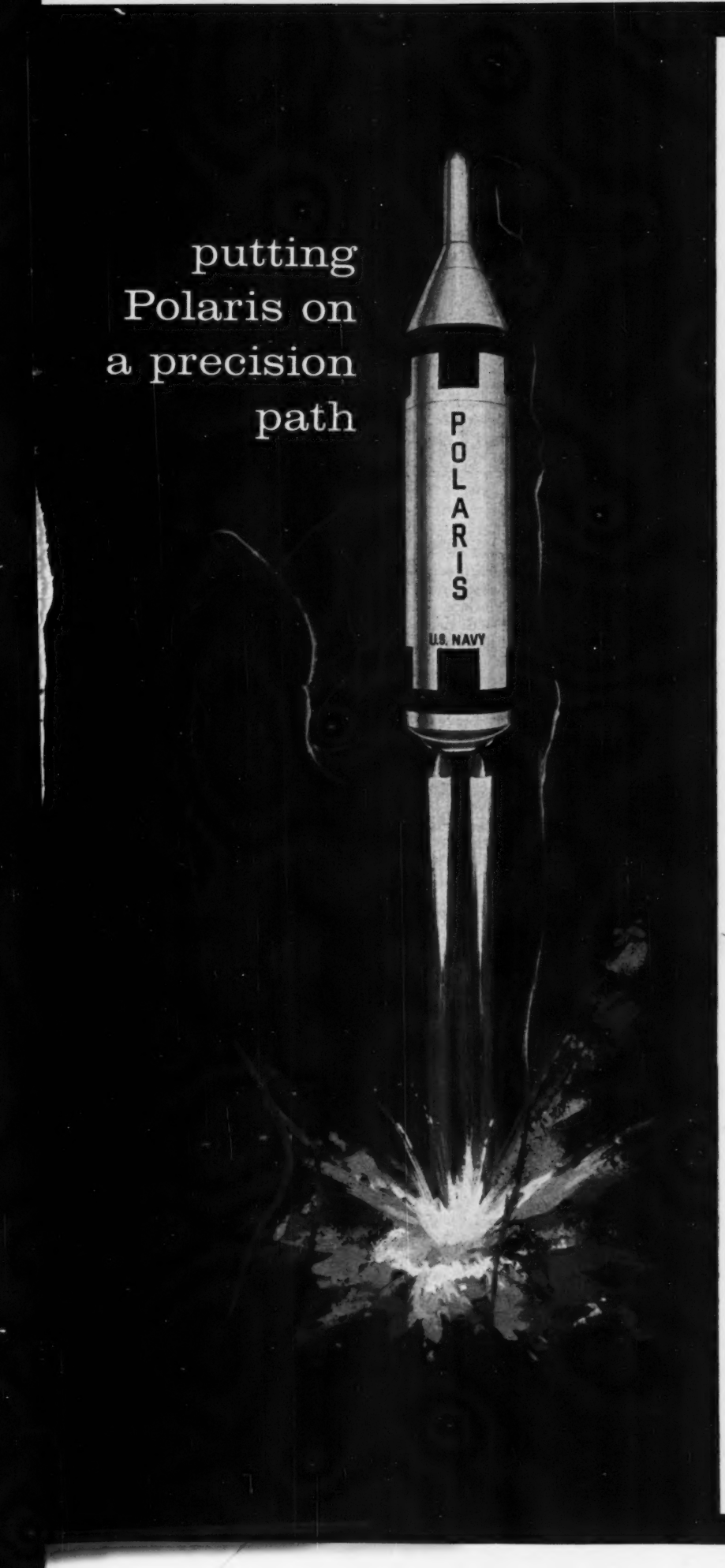

Several new contracts for research and development of computer and guidance components for the Polaris Missile have recently been awarded to the Hughes Engineering Division. As a result, a variety of openings have been created for graduate engineers and scientists who have a minimum of three years experience specifically related to:

- Inertial Components and Platforms
- Systems Design and Physical Design of Inertial Devices
- Digital Computers
- Servomechanisms
- Controls Systems Analysis
- Magnetic Drum and Magnetic Core Circuit Design
- Transistor Switching and Circuit Design

Polaris Guidance is but one of the many R&D programs which reflect the growing emphasis on space oriented projects at Hughes. The Engineering Division is also responsible for such projects as: Space Ferry Systems, Anti-ICBM Detection Systems, Infrared Search Systems, and Communications Satellites.

For immediate consideration, please write, wire or call: **Mr. R. A. Martin**
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Trade Literature...

Microwave Catalog . . .

LEL Catalog No. 60 provides 32 pages of information on microwave receiver front ends, including data on a number of waveguide and coaxial mixer-preamplifier assemblies. Other products described include solid-state, miniature, and subminiature i-f amplifiers, traveling-wave tube amplifiers, octave r-f amplifiers, beacons, and automatic frequency control units. Catalogs may be obtained by writing to *LEL, Inc., 380 Oak St., Copiague, L.I., N.Y.*

Nitroneal Generator Data File . . .

Of interest to industrial users of nitrogen or nitrogen-hydrogen mixtures, a new booklet provides detailed descriptions of equipment with capacities ranging from 50-100 up to 2,500-10,000 standard cubic feet per hour, including flow diagrams, price lists, and operating cost figures. The Nitroneal Generator catalytically reacts air and ammonia over a platinum catalyst to product oxygen-free nitrogen gas with a controllable hydrogen content of from 0.5 to 25%. No carbon compounds, sulfur compounds, or oxides of nitrogen are formed by the catalytic reaction. The gas generated contains less than one part per million of oxygen. *Technical Information Dept., Engelhard Industries, Inc., 75 Austin St., Newark 2, N.J.*

Application-Note Index . . .

A complete index of some 40 application notes issued by Hewlett-Packard Company over the past several months presents useful abstracts of each of these notes. Of interest to users of electronic measuring instruments, the notes describe electronic theory, measurements, and applications of the company's instruments. Typical topics covered are traveling wave amplifiers, solid-state devices, masers; various frequency, microwave, and current measurements; and applications for oscilloscopes and oscillators. Having selected from the index those notes which interest him, the reader can then obtain the notes by writing the company or the local engineering representative and requesting them by number and title. *Hewlett-Packard Company, 1501 Page Mill Rd., Palo Alto, Calif.*

Tape Usage Folder . . .

A 4-page booklet tells how 10 years of maintenance-free life were built into new vendors through help of Dutch Brand Rub'R-Shim sponge rubber strapping. Details are given on the use of tapes to help in improving product quality and appearance. *Johns-Manville, Dutch Brand Div., 7800 South Woodlawn Ave., Chicago 19, Ill.*

Magnetic Particle Clutches . . .

A catalog describing characteristics of a line of magnetic particle clutches ranging in capacity from 2.5 ounce-inches (0.156 pound-inches) to 1,900 pound-inches, uses curves, installation drawings, and other illustrations to acquaint design engineers with 10 different series of clutches and their possible uses. The 16-page 2-color brochure is available from *James D. Canfield, Lear, Inc., Box 688, 110 Ionia Ave., N.W., Grand Rapids, Mich.*

Ultrasonic Flaw Detection Bulletin . . .

Bulletin T200 includes operation, techniques, and a complete list of specifications for the Sonoray 5 flaw detector. The 8-page illustrated bulletin describes advantages of a new pulse-echo instrument, which has exceptional low-frequency resolving power and penetration. By sending short pulses of acoustic energy at ultrasonic frequencies into the object under test, the flaw detector can examine the interior of metals, glass, plastics, even body tissue, from one side only, and without physical damage. Principles of pulse-echo testing, by both reflection and through-transmission techniques, are explained in the booklet with schematic drawings. To illustrate the detection of flaws in objects of various shapes and materials, cut-away diagrams show the path of the pulse through the test piece, and indicate typical traces. In addition to describing techniques, such as use of straight beams, angle beams, and surface waves, the bulletin discusses application of contact, immersion, and water column testing methods. *Brandon Instruments, Inc., 40 Brown House Rd., Stamford, Conn.*

(Continued on page 48A)

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Review of Input and Output Equipment Used in Computing Systems

(March 1953)

The Joint AIEE-IRE-ACM Computer Conference took place on December 10-12, 1952, in New York, N. Y., to discuss the characteristics and performance of input-output equipment as it applies to large-scale electronic digital computers. The conference was held under the direction of the Joint Committee appointed by the Committee on Computing Devices of the American Institute of Electrical Engineers, the Electronic Computers Committee of the Institute of Radio Engineers, and the Council of the Association for Computing Machinery.

Input-output equipment presents an ever-changing and expanding problem and encompasses a very broad field of devices. This conference stressed those devices which have been brought to the point of working equipment by the various computing groups in an attempt to acquaint a large body of engineers with the present status of the art. The 142 printed pages contain 27 pages and discussions, representing a fairly complete documentation of the input-output art as it existed at the time of publication.

Publication S-53 is available at the price of $4.00 to members and nonmembers. Send orders to Order Department.
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When answering an advertisement, send all replies to box number specified, c/o ELECTRICAL ENGINEERING, 6th Floor, 33 West 39th Street, New York 18, N. Y., unless other address is given.

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PROFESSOR OR ASSOCIATE PROFESSOR of Electrical Engineering to teach and do research in the field of communications. Should have Ph.D., teaching and research experience. Write Box 56.

ASSISTANT OR ASSOCIATE PROFESSOR for Electrical Engineering Department. M.S. or Ph.D. degree required. Opening in electronics. Salary commensurate with qualifications. Position available September 1960. Write Head, Electrical Engineering Department, South Dakota School of Mines and Technology, Rapid City, South Dakota.

ELECTRICAL ENGINEER. Board layout work-power, lighting, and control systems; calculations; and occasional field contacts. Extremely wide variety of work with opportunity to enter consulting field and grow with progressive mid-western concern. Write to Box number 95.

ELECTRICAL ENGINEER experienced in power and lighting design for Commercial, Industrial and Institutional Buildings. In reply, please state education, experience and salary requirements. J. N. Pease & Co., Architects-Engineers, P.O. Box 10336, Charlotte, N.C. Att: T. L. Cordle.

SYNCHRO DESIGN ENGINEER—Electrical engineer with several years design experience in synchro and related precision components with well established company in the component field. This position will involve long range development to expand existing component lines. All replies will be acknowledged. Please forward in confidence your complete resume to: Robert J. Newton, G-M Laboratories, Inc. 4300 N. Knox Avenue, Chicago 41, Illinois.

ELECTRICAL ENGINEERS—Pioneer manufacturer of large rotating AC induction and synchronous motors, generators, motor control and switchgear has challenging opportunity for aggressive and ambitious young men as application engineers in headquarters sales department. Stimulating work which can also lead to field sales if desired. Salary open. Commensurate with ability and experience. Write Box 97.

Positions Wanted

ELECTRICAL ENGINEER — Graduate Swiss Federal Institute Technology, 32 years, single. Nine years experience: Utilities, mining, chemicals: diesel-, steam-, hydro-electric plants, industrial engineering, electrical distribution & transmission: engineering, field work, operation, maintenance, technical correspondence. Fluent English, Spanish, French, German. Present location South America. Future location open. USA or abroad. Available soon interview USA. Write to Box 98.

ENGINEER-SALES. Sales oriented electrical engineer (Canada) age 32 GE test 9 years extensive power and distribution apparatus sales experience. Successful agency and factory branch office background, seeks remunerative satisfying association with West Coast or Hawaiian agent or manufacturer. For resume write Box 96.

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- Microwave field engineers
- Transistor switching circuit design
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Trade Literature

(Continued from page 46A)

Electric Typewriter for Physicists . . .

A method of using an electric typewriter for quick, convenient typing of special symbols and equations used in the field of physics is the subject of a 12-page booklet which is the sixth in a series designed to show how many different fields can make profitable use of interchangeable typewritten type. This method insures clean, neat type for ordinary purposes and for specialized requirements. With the interchangeable type bar, the typist can insert special type characters herself in a matter of seconds. There is no need for an extensive knowledge of typewriter parts or for relearning the keyboard. Only the type face (or head) is changed. It snaps into place on the interchangeable type bar in one simple operation, and is locked, or removed, with special magnetized tweezers. A copy of booklet R-8964.14 can be obtained at any company branch office, or by writing to *Remington Rand, 315 Park Ave. S., New York 10, N. Y.*

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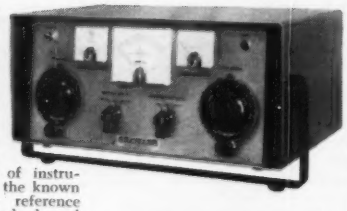

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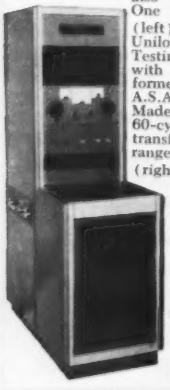

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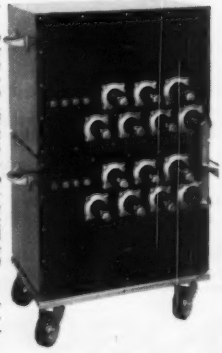

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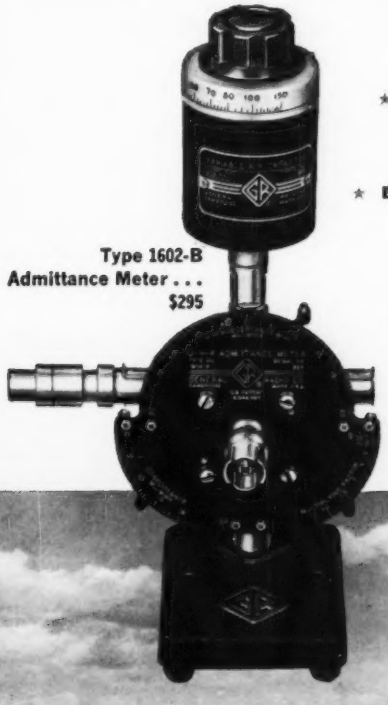

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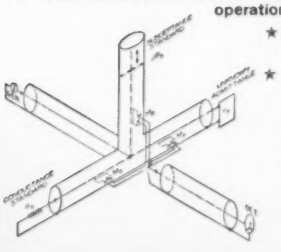

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